



## Second axis Energy and natural Resources

# Chapter One Environmental Resources

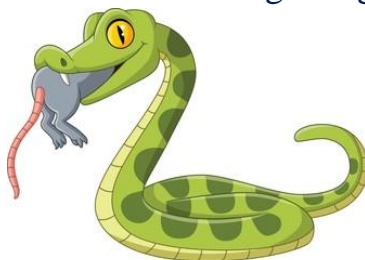
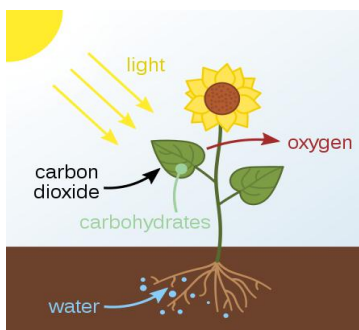
## Lesson One The transfer of energy in ecosystems

*The aim is to understand how energy from the sun is transferred within the ecosystem.*

### Concept of Energy in Ecosystems:

Energy transfer between organisms in an ecosystem is based on interactions within the food web.

the different roles of organisms in transferring energy, such as producers and consumers.



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A snake preys on a mouse



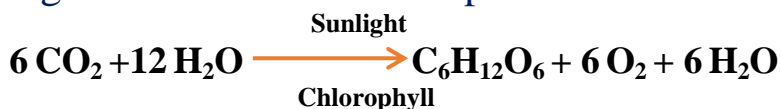
fungi gets its food from the trunk

A plant obtains food through photosynthesis.

### Photosynthesis and Energy Production:

When sunlight hits plants, they perform a process called photosynthesis.

In Photosynthesis process, plants convert solar energy into chemical energy that is stored in sugar molecules inside the plants.



### ➤ Energy Transfer through Food Chains

When an insect feeds on a plant, it gains the chemical energy stored in the plant's sugars. This energy moves from the plant to the insect. When another animal eats the insect, the energy transfers to the animal.

With each transfer from one level to another, an amount of energy is lost.

Scientists use food chains and food webs to model this energy transfer in an ecosystem.

Each step in a chain or web is called a **trophic level**, and organisms that rely on others for nutrition form different levels in the chain. Producers, or primary sources of energy, exist at the first level in all ecosystems, while consumers form the other levels.



## Scientific activity



Look at the corresponding food chain

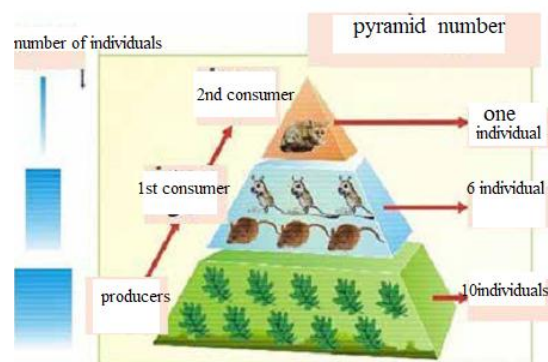
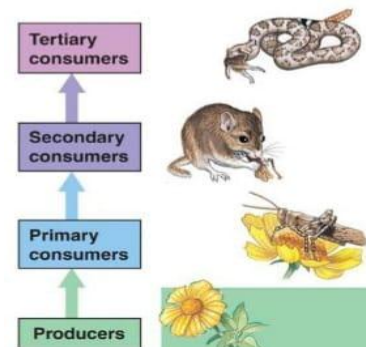
- (1) How many trophic levels are there?
- (2) Which living organism receives the least amount of energy produced by the plant?

## ❖ Energy measurement and transmission:

The pyramid of energy transfer is used to know the number of organisms that depend on the same source of energy and thus we can determine the efficiency of energy transfer

The efficiency of energy transfer usually is about 10%, while 90% of energy is lost through vital processes such as excretion and respiration in which the largest amount of glucose (chemical energy) is consumed

Because of this loss of energy, the energy pyramid rarely (not) has more than six levels as the remaining part of the energy becomes too little to be used as food for another organism. Therefore, it is better in terms of energy for humans to get their food directly from the plant than from the animals that feed on the plant (Due to 90% of energy is lost through vital processes)



## ❖ Calculation of lost energy:

The expression lost energy is not contrary (not different) to the law of energy conservation where animal loses part of the energy mainly in the form of heat during its vital processes like respiration

## Example

Suppose that the amount of energy that the rabbit gets from the plant is 100 J

1- The largest of this amount is transformed during the process of sugar combustion (burning) in the breath of the gas into carbon dioxide gas (chemical energy) return to the nature in the process of exhalation,

2- Part to kinetic energy that helps the animal to move,

3- Part to thermal energy to warm the body,

4- the remaining part stored in the not digested food is (chemical energy) as wastes return to the soil in the process of excretion.





When all these energies are combined together, they find J100, which is consistent with the law of conservation of energy, and therefore the lost energy is meant to be unused energy

**The energy lost during respiration and excretion represents** the difference between the total energy of the organism's food and the energy used in vital processes such as growth and growth

## ❖ Energy conservation

The law of energy conservation is shown in the food chain through the energy changes in different forms.

**The chain begins with light energy** from the sun, which is converted within the plant into **chemical energy** stored in the food formed during photosynthesis.

This energy is transferred to the first consumer when it feeds on the plant, where the **chemical energy is converted during the respiration** process into **thermal** and **kinetic** energy, with the loss of part of the energy in a heat form

When energy is transferred to the **second consumer** that feeds on the first one, additional **energy loss occurs during breathing and excretion**

**These transformations continue until the energy reaches the decomposers**, which return the **remaining chemical energy from the dead organisms** to the soil in the form of salts. Throughout the food chain, part of the energy is lost at each level.

This does not contrary (not different) the law of conservation of energy,

**Law of conservation of energy that energy does not perish but is transformed from one form to another**

### Scientific activity



Suppose a plant receives 1000 J from solar energy, and uses only 2% of this energy in the process of photosynthesis, and the other part is lost in the form of heat, reflection or absorption in other parts, calculate

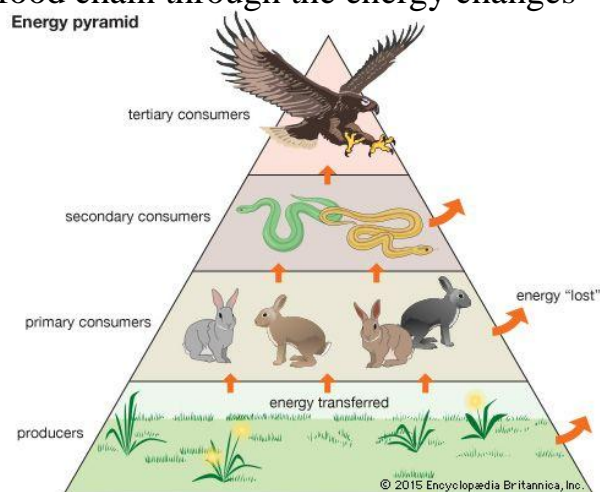
1.The amount of energy a plant uses in photosynthesis

.....

2.The amount of energy lost .

.....

Energy pyramid



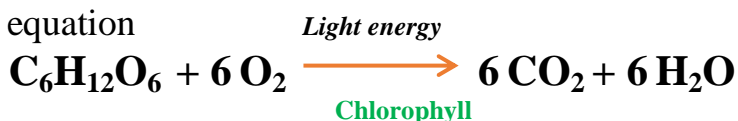




### ❖ Chemistry in Energy Transfer:

In photosynthesis process, which occurs inside the green plastids (plant-specific cellular organelles), complex chemical reactions occur where the reaction begins to absorb light by chlorophyll (the pigment in plants). Light catalyzes chemical reactions that lead to the conversion of carbon dioxide and water into glucose and oxygen,

as illustrated by the equation



Other living organisms in the food chain use the chemical energy stored in the glucose when they feed -directly or -indirectly on plants.

When glucose (living fuel) burns inside the organism's body (the process of respiration), thermal energy is generated and this energy is responsible for the life of the organism.



Thus, the energy has been converted from light energy to chemical energy stored within the chemical bonds in a glucose molecule to heat energy responsible for survival of organisms.

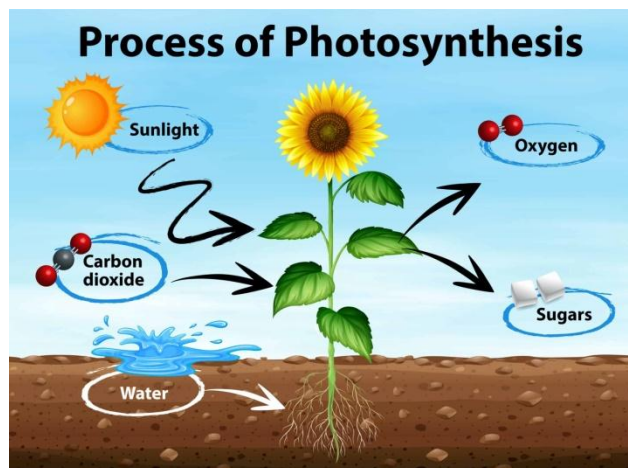
### ❖ Energy stored inside fossil fuels:

The formation of fossil fuels such as coal, petroleum and natural gas depends on living organisms that have stored the solar energy directly or indirectly.

Coal is mainly carbon (C) may be from the remains of trees and plants decomposed in the ground since millions of years.

Petroleum, which is a mixture of several hydrocarbon compounds, may be from marine organisms and marine plants, buried millions of years ago and decomposed under the high pressure and temperature.

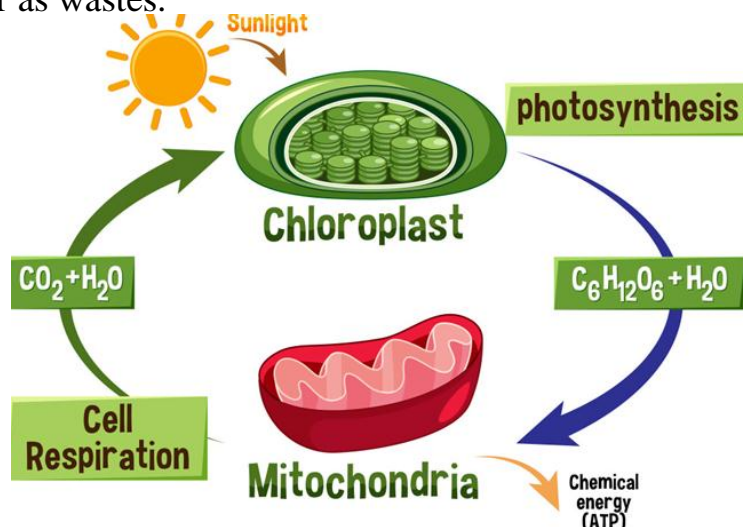
Natural gas, which consists of a mixture of several hydrocarbon gases, such as methane gas (70-98%), and small percentages of ethane, propane and butane gas, is found floating on the surface of petroleum in the subsoil or inside coal mines and rock structures.





## ❖ The relation between photosynthesis and cellular respiration

These reactions contribute to maintaining the balance of oxygen and carbon dioxide in the envelope. Plants produce oxygen and store energy in glucose, while other living organisms (animals and humans) consume oxygen and use glucose to produce energy, release carbon dioxide and water as wastes.



## ❖ Impact of this relationship on the ecosystem:

### 1. Environmental balance:

The relationship between photosynthesis and cellular respiration helps maintain the balance of gases in the atmosphere. Plants produce oxygen and capture carbon dioxide during photosynthesis, while other organisms consume oxygen and produce carbon dioxide.

During the breathing process, which maintains the ecological balance.

### 2. Energy flow:

Solar energy stored in glucose molecules through photosynthesis is passed up the food chain when plants are consumed by animals. This energy is used in cellular respiration to produce ATP (adenosine triphosphate), the main energy source for all cellular processes in living organisms.

### 3. Carbon Cycle:

Photosynthesis and cellular respiration contribute to the natural carbon cycle, in which carbon dioxide and water are recycled between the environment and living organisms.

In cellular respiration, photosynthesis provides glucose and oxygen which release energy. This integration between photosynthesis and cellular respiration ensures the flow of energy and the balance of gases in the ecosystem, supporting life on planet Earth.



# Questions

## MCQs on Energy Transfer in Ecosystems

**1-What is the primary source of energy for most ecosystems?**

- A) Wind      B) Solar energy      C) Geothermal energy      D) Nuclear energy

**2-Which process do plants use to convert solar energy into chemical energy?**

- A) Cellular respiration      B) Photosynthesis      C) Fermentation      D) Decomposition

**3-What are autotrophs?**

- A) Organisms that consume other organisms  
B) Organisms that produce their own food  
C) Organisms that decompose organic matter  
D) Organisms that cannot produce energy

**4-In a food chain, which organism typically occupies the first trophic level?**

- A) Primary consumer      B) Secondary consumer  
C) Tertiary consumer      D) Producer

**5-What is the approximate percentage of energy transferred from one trophic level to the next?**

- A) 5%      B) 10%      C) 50%      D) 90%

**6-What happens to the majority of energy as it moves up trophic levels?**

- A) It is stored      B) It is converted to heat  
C) It is used for growth      D) It is absorbed by the soil

**7-Which of the following is a primary consumer?**

- A) Deer      B) Grass      C) Wolf      D) Fungi

**8-What do decomposers do in an ecosystem?**

- A) Produce energy      B) Consume other organisms  
C) Break down dead organic matter      D) Store energy

**9-What is a food web?**

- A) A linear representation of energy flow  
B) A complex network of feeding relationships  
C) A single food chain      D) A type of ecosystem

**10-Which of the following is a secondary consumer?**

- A) Grass      B) Grasshopper      C) Frog      D) Plant

**11-During photosynthesis, plants convert carbon dioxide and water into:**

- A) Oxygen and glucose      B) Nitrogen and glucose  
C) Carbon monoxide and sugar      D) Oxygen and ethanol

**12-Which pigment is primarily responsible for absorbing light in plants?**

- A) Carotene      B) Chlorophyll      C) Xanthophyll      D) Anthocyanin

**13-What role do herbivores play in an ecosystem?**

- A) Producers      B) Primary consumers      C) Decomposers      D) Tertiary consumers



**14-What is the energy loss during respiration primarily converted into?**

- A) Light energy    B) Kinetic energy    C) Heat energy    D) Chemical energy

**15-What is the main product of cellular respiration?**

- A) Oxygen    B) Glucose    C) Carbon dioxide    D) Water

**16-Which of the following statements is true about energy transfer in food chains?**

- A) Energy is created at each level    B) Energy is lost at each level  
C) Energy remains constant at all levels    D) Energy is only gained by producers

**17-What is a trophic level?**

- A) A type of ecosystem    B) A position in a food chain  
C) A species of plant    D) A type of energy

**18-What do plants absorb to perform photosynthesis?**

- A) Nitrogen    B) Carbon dioxide    C) Oxygen    D) Hydrogen

**19-Which organisms are known as primary producers?**

- A) Herbivores    B) Carnivores    C) Plants    D) Decomposers

**20-What is the role of sunlight in photosynthesis?**

- A) It cools the plants    B) It provides energy for the reaction  
C) It produces glucose    D) It absorbs carbon dioxide

**21-In which organelle does photosynthesis occur?**

- A) Mitochondria    B) Nucleus    C) Chloroplast    D) Ribosome

**22-Which of the following is NOT a greenhouse gas?**

- A) Carbon dioxide    B) Methane    C) Nitrogen    D) Water vapor

**23-What is the main source of energy for cellular respiration?**

- A) Glucose    B) Oxygen    C) Carbon dioxide    D) Light

**24-What happens to energy when an animal consumes a plant?**

- A) It is destroyed    B) It is transformed into chemical energy  
C) It is lost as heat    D) It is transferred to the soil

**25-Which type of consumer feeds on both plants and animals?**

- A) Herbivore    B) Carnivore    C) Omnivore    D) Decomposer

**26-What is the importance of decomposers in an ecosystem?**

- A) They produce energy    B) They recycle nutrients  
C) They consume plants    D) They compete with primary consumers

**27-How is energy stored in plants?**

- A) As heat    B) As chemical energy in glucose  
C) As light    D) As kinetic energy

**28-What is the energy pyramid?**

- A) A model of energy transfer in ecosystems    B) A type of plant  
C) A geological formation    D) A type of climate



**29-How do fossil fuels store energy?**

- A) As thermal energy      B) As chemical energy  
C) As light energy      D) As kinetic energy

**30-What happens to the energy stored in glucose during cellular respiration?**

- A) It is lost to the environment      B) It is converted into ATP  
C) It is stored as fat      D) It is used for photosynthesis

**31-What process do decomposers use to break down organic material?**

- A) Photosynthesis      B) Respiration      C) Fermentation      D) Decomposition

**32-What is the main byproduct of photosynthesis?**

- A) Carbon dioxide      B) Glucose      C) Oxygen      D) Water

**33-Which of the following is a biotic factor in an ecosystem?**

- A) Soil      B) Water      C) Plants      D) Temperature

**34-What role do carnivores play in an ecosystem?**

- A) Primary producers      B) Primary consumers  
C) Secondary consumers      D) Decomposers

**35-What is the primary function of chlorophyll?**

- A) To absorb oxygen      B) To absorb light  
C) To store energy      D) To release carbon dioxide

**36-How do plants impact the carbon cycle?**

- A) By producing carbon dioxide      B) By absorbing carbon dioxide  
C) By consuming fossil fuels      D) By releasing methane

**37-What is the role of the mitochondria in cells?**

- A) Photosynthesis      B) Energy production  
C) Protein synthesis      D) Cell division

**38-How do humans impact energy transfer in ecosystems?**

- A) By conserving energy      B) By polluting environments  
C) By increasing biodiversity      D) By enhancing photosynthesis

**39-What do plants release as a byproduct of photosynthesis?**

- A) Glucose      B) Nitrogen      C) Oxygen      D) Carbon dioxide

**40-What is the main energy currency of cells?**

- A) Glucose      B) ATP      C) NADPH      D) ADP





## Lesson Two Conservation of environmental resources

How everyday activities like driving or using chemicals in the home affect the environment?  
How human activities affect environmental resources and how we can conserve them using principles of chemistry, physics, and life sciences.

how we can apply these scientific concepts to develop effective conservation strategies.

### ➤ The efficiency of energy conversion systems and their impact on the environment

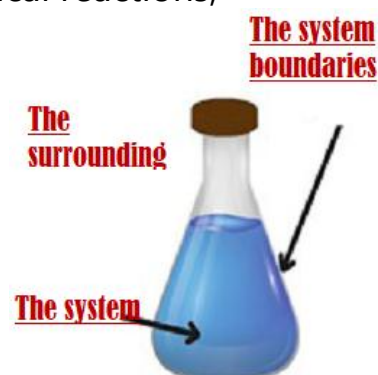
The efficiency of a system used in energy consuming indicates its ability to effectively convert a form of energy into the desired energy form. More efficient systems are those that reduce unwanted energy production through them, reducing energy consumption rates.

### ❖ Basic Concepts of Thermodynamics

**Thermodynamics** is concerned with studying the concepts of energy and its transformations accompanying physical processes, chemical reactions, biological processes, and others.

**The system:** It is the part of the universe in which the chemical or physical change occurs or it is the part of the matter to which the study is directed

**The surrounding:** It is the part that surrounds the system and exchanges energy with it in the form of heat or work and can be real or imaginary



**The system boundaries:** It is the one who encircles the system and separates it from the surrounding medium and it represents the wall of the container containing the system

**For example,** when a solution of hydrochloric acid is added to a solution of sodium hydroxide (alkali) in a glass flask,

**The system** is a solution of acid and alkali,

**The boundaries of the system** are the walls of the flask,

**The surrounding** is the rest of the universe around the flask.



## ➤ Types of Systems

<u>Open System</u>	<u>Closed System</u>	<u>Isolated System</u>
It is the system that allows the exchange of both matter and energy between the system and the surrounding medium.	It is the one that allows energy exchange only between the system and the surrounding medium.	It does not allow any transfer of energy or matter between the system and the surrounding medium.
<b>Example:</b> A metal pot containing boiling water. It is observed that the substance of the system, which is water, rises in the form of water vapor into the surrounding medium, and the heat of the water (its energy) also leaks into the surrounding medium.	<b>Example:</b> If metal container is tightly closed, the heat of the water will leak into the surrounding medium while the amount of water (the system substance) remains constant	<b>Example:</b> The heat of the material (thermos) as it preserves the heat of the system and its material from leaking into the surrounding



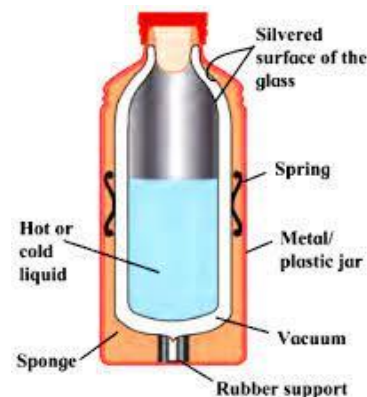
Open system



Closed system



Isolated system



Thermos flask

## ❖ The system properties

The natural properties of the system can be divided into two groups:

<u>Extensive properties</u>	<u>Intensive properties</u>
Properties that depend on the amount of material in the system such as mass, volume, heat capacity, internal energy, and surface area	Characteristic properties of the material that do not depend on its quantity in the system, such as the temperature, density, surface tension, and specific heat of the material



## ❖ Laws of thermodynamics:

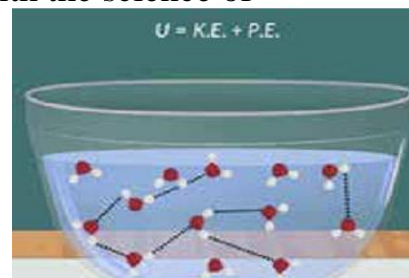
Many physical processes, chemical reactions, and vital processes within living bodies, and energy changes are explained based laws associated with the science of thermodynamics

### The first law of thermodynamics:

Heat is a form of energy, therefore it is subjected to the law of conservation of energy or the first law of Thermodynamics which states that:

Energy is neither created nor destroyed and it is transformed from one form to another. Thus, the total energy of a system remains constant

Each system with clear boundaries contains a specific amount of **internal energy (U)**



The internal energy of a system or body is the sum of the kinetic energy of the system molecules and the potential energy associated with the attractive forces between them

We can create a change in the internal of a system  $\Delta U$  by two ways:

- 1) Transfer a quantity of heat energy  $\Delta Q$  to or from the system.
- 2) The system has made a work  $\Delta W$  against external force acting on it, or work done on the system.

The first law of liberal dynamics can be expressed in the following mathematical form:

$$\Delta U = \Delta Q - \Delta W$$

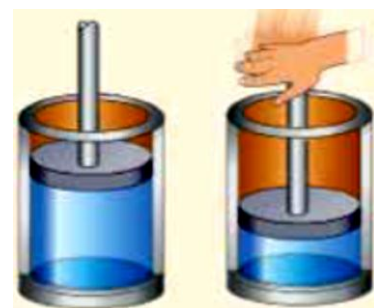
The value of  $\Delta Q$  is **positive (+)** for the amount of heat that the system gains from the surrounding and **negative (-)** for the amount of heat that the system loses to the surrounding.

The value of  $\Delta W$  is **positive (+)** for the work done by the system on the surrounding, and **negative (-)** for the work done by the medium load on the system

### Notes

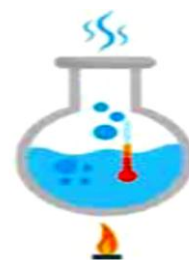
1) If no heat is transferred to or from the system, then ( $\Delta Q = 0$ ), hence ( $\Delta U = \Delta W$ ) and it is called **the Adiabatic process**.

Example: Rapid compression of a quantity of trapped gas





2) If the temperature of the system doesn't change, and therefore its internal energy remains constant, then ( $\Delta U = 0$ ), and therefore ( $\Delta Q = \Delta W$ ), it is called the **isothermal process**.



Example: Both the melting of the ice and the boiling of the water are done at a constant temperature

3) If the volume of the system does not change, and therefore there is no work done by the system or the surrounding, then ( $\Delta W = 0$ ), and therefore ( $\Delta Q = \Delta U$ ), it is called the **Isochoric process**.



Example: heating the water in an airtight container or pressure cooker

### Example of the first law of thermodynamics

**a. The electric bulb:** When the bulb is working, the **electrical energy** is converted into **thermal** energy and **light** energy in the filament of the lamp.

**b. Photosynthesis:** Plants carry out photosynthesis, where the **light energy** coming from the **sun** is transferred to oxygen and organic compounds that store **chemical energy**, and then herbivorous animals get this energy when feeding on plants, then the energy reaches carnivorous animals when they prey on herbivores, and during these processes **energy transfer is gained and lost thermal energy** within the system

### **Example:**

**In a cylinder, a gas is compressed very slowly to half its original volume and during this process the degree of heat remained constant and the work expended in compression was 45 J, calculate**

1. How much change in the internal energy of the system?
2. How much the quantity of heat has moved to the gas?

### **The Solution**

- The temperature of the system is constant during the change, the amount of internal energy also remains constant, so  $\Delta U = 0$
- From the first law of thermodynamics

$$\Delta U = \Delta Q - \Delta W \implies 0 = \Delta Q - \Delta W$$

$$\Delta Q = \Delta W \implies \Delta Q = \Delta W = 45 \text{ J}$$





## ❖ Efficiency of energy conversion and energy conservation Energy processes:

Efficiency of energy process: It expresses the ratio of useful energy transferred through different levels compared to the input energy



### Practical example

**If we start with sunlight as an energy source in an ecosystem, it is converted into chemical energy in plants, then into kinetic energy in animals, and part of this energy will be lost as heat at each stage, so the efficiency of the energy transfer process decreases from one level to another. However, according to the first law of thermodynamics, the total amount of energy remains constant**



## ❖ Chemistry and energy:

### There relation between chemical reactions and conservation of energy

**A chemical reaction can be expressed as a chemical equation:**



**In chemical reactions, we treat the amounts of reactants or products of the reaction in unit of Mole**

**A mole of a substance** is a mass of a substance in grams that is equal to its molecular mass.

**For example**, the mass of a mole of water ( $\text{H}_2\text{O}$ ) is ( $18\text{g} = (16) + 1 \times (2)$ ), and the mass of a mole of carbon dioxide ( $\text{CO}_2$ ) is  $44\text{g}$ .

**The heat content (H)** of a substance is the amount of chemical energy stored within a mole of a substance.

Chemical energy is stored in the atoms and molecules of the substance, in the chemical bonds, and in the forces of attraction between its molecules. Since the molecules of substances differ in the types of atoms that make them up, their number, and the types of bonds between them, the heat content differs from one substance to another.

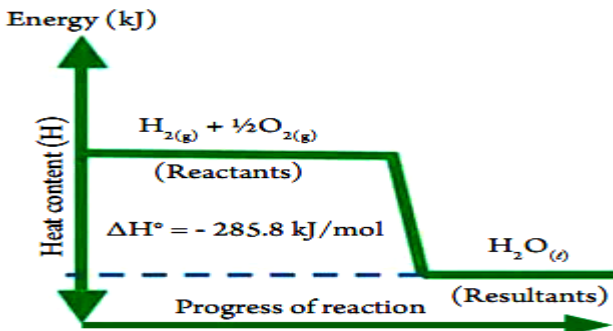
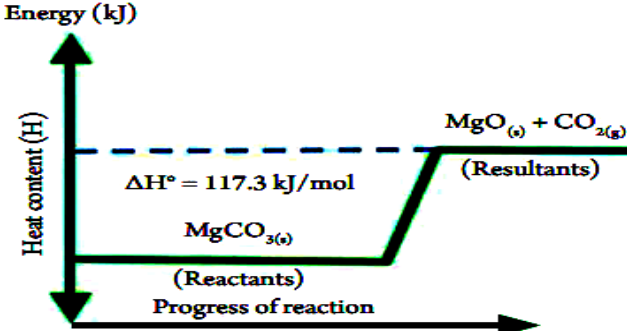
**The atomic mass:** the mass of the atom

**The molecular mass:** Sum of atomic masses of the atoms forming the molecule

**Change in heat content  $\Delta H$**  = heat content of products  $H_P$  - heat content of reactants  $H_R$



## ➤ Types of heat changes accompanying the chemical reactions:-

<u>Exothermic reactions</u>	<u>Endothermic reactions</u>
The reactions that <b>produce</b> heat to the surrounding causing an <b>increase</b> in its temperature	The reactions that <b>absorb</b> heat from the surrounding causing a <b>decrease</b> in its temperature
- Heat transfers from the system to the surrounding	- Heat transfers from the surrounding to the system
(which leads to decrease the temperature of system and increase the temperature of surrounding)	(which leads to increase the temperature of system and decrease the temperature of surrounding)
$\text{H}_{2(g)} + \frac{1}{2} \text{O}_{2(g)} \rightarrow \text{H}_2\text{O}_{(l)} + 285.85 \text{ kJ/mol}$	$\text{MgCO}_{3(s)} + 117.3 \text{ kJ/mol} \rightarrow \text{MgO}_{(s)} + \text{CO}_{2(g)}$
	
<u>-ΔH is a negative value (G.R)</u>	<u>- ΔH is a positive value (G.R)</u>
Because the heat content of products is <u>less</u> than the heat content of reactants	Because the heat content of products is <u>more</u> than the heat content of reactants
$H_{\text{prod}} < H_{\text{react}}$	$H_{\text{prod}} > H_{\text{react}}$

$$\Delta H^{\circ} = H_{\text{products}} - H_{\text{reactants}}$$

- The surrounding also contains the solvent and the air which surrounds the reaction container

### Measuring units of quantity of heat

**Calorie:** the quantity of heat required to raise the temp. of 1 g of water 1 °C (20° : 21°)

**Joule:** the quantity of heat required to raise the temp. of 1 g of water 1/4.18 °C

$$1 \text{ calorie} = 4.18 \text{ joules}$$

1 kcal = 1000 cal.

Kilo joule = 1000 joules

Kilo calorie = 4180 joules



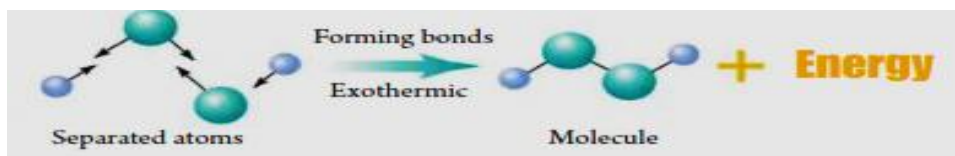
## The heat change that accompany a chemical reaction:

In a chemical reaction, the chemical bonds in the reactants are broken and new bonds are formed in the resultants molecules of the. Breaking the bond requires some amount of energy from the surrounding

1. During the **breaking** of the bond, energy is **absorbed** from the surrounding



2. During the formation of the bond, energy is **released** to the surrounding



The bond energy differs according to the type of compound or its physical state. Therefore, scientists used the average bond energy instead of the bond energy

Average bond energy kj/mol	the bond
432	H—H
358	C—O
803	C=O
467	O—H
498	O=O

Average bond energy kj/mol	the bond
346	C—C
610	C=C
835	C≡C
413	C—H
389	N—H

1. When the absorbed energy during bond breaking in reactants is **less** than the released energy during bond formation in reactants, the reaction is **exothermic** ( $\Delta H$  is **negative**)
2. When the absorbed energy during bond breaking in reactants is **more** than the released energy during bond formation in reactants, the reaction is **endothermic** ( $\Delta H$  is **positive**)

$$\Delta H = \text{bond breaking} + \text{bond formation}$$

In reactants  
+ve

in products  
-ve



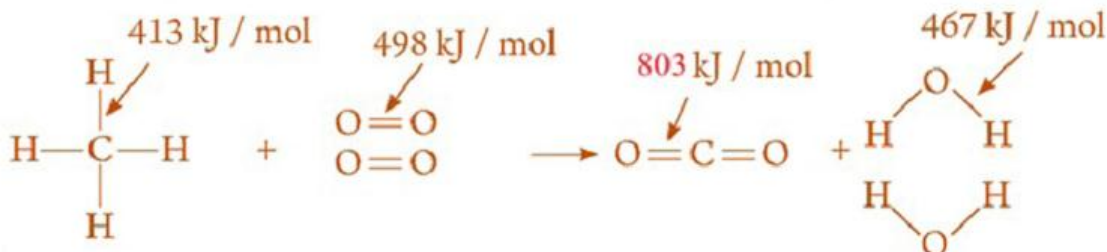


**-Calculate the heat change in the following reaction and determine whether the reaction is exothermic or endothermic?**



where the bond energy is as follows:

(C=O: 803, O-H: 467, C-H: 413 O=O :498)



Energy required to break the bonds of the reactants

$$4 \times (\text{C-H}) + 2 \times (\text{O=O}) = 4 \times 413 + 2 \times 498 = 2648 \text{ KJ}$$

Energy released from forming the product bonds

$$2 \times (\text{C=O}) + 2 \times 2 (\text{OH}) = 2 \times 803 + 2 \times 2 \times 467 = 3474 \text{ KJ}$$

$\Delta H$  = Total energy released + Total energy absorbed

$$= (+2648) + (-3474) = -826 \text{ KJ/mol}$$

Thus, the reaction is **exo**thermic because the sign ( $\Delta H$ ) is negative.

**1) Calculate  $\Delta H$  of the following reaction**



If the bond energies are (C-H) 104kJ, (Cl-Cl) 58kJ, (C-Cl) 84 kJ and (H-Cl) 107 kJ Then mention the type of the reaction

.....

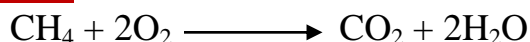
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**2) Calculate  $\Delta H$  of the following reaction and determine if the reaction is exothermic or endothermic**



If the bond energies are (C=O) 745kJ, (O - H) 467 kJ, (C-H) 104kJ, (O=O) 498 kJ

.....

.....

.....

.....

.....



# Questions

## MCQs on Conservation of Environmental Resources and Energy Efficiency

### 1-What is the primary goal of energy conservation?

- A) To increase energy consumption    B) To reduce energy waste  
C) To develop new energy sources    D) To promote fossil fuel usage

### 2-Which of the following is a method to improve energy efficiency in homes?

- A) Using incandescent bulbs    B) Sealing windows and doors  
C) Leaving appliances on standby    D) Using older appliances

### 3-What does the term "thermodynamics" relate to?

- A) The study of chemical reactions only    B) The study of energy transformations  
C) The study of ecological systems    D) The study of atmospheric conditions

### 4-In an isolated system, what can be exchanged with the surroundings?

- A) Matter and energy    B) Only energy  
C) Only matter    D) Neither matter nor energy

### 5-What type of system allows both matter and energy to be exchanged?

- A) Closed system    B) Open system    C) Isolated system    D) None of the above

### 6-Which of the following is an example of an exothermic reaction?

- A) Melting ice    B) Photosynthesis  
C) Combustion of fuels    D) Dissolving ammonium nitrate in water

### 7-What is a key indicator of energy efficiency in appliances?

- A) Size of the appliance    B) Energy consumption rating  
C) Color of the appliance    D) Brand name

### 8-The first law of thermodynamics states that:

- A) Energy can be created and destroyed    B) Energy is always lost in transformations  
C) Energy can neither be created nor destroyed    D) Energy is only converted to heat

### 9-Which of the following energy transformations occurs during photosynthesis?

- A) Light energy to chemical energy    B) Chemical energy to mechanical energy  
C) Thermal energy to kinetic energy    D) Electrical energy to light energy

### 10-What is the main byproduct of exothermic reactions?

- A) Heat    B) Light    C) Water    D) Carbon dioxide

### 11-How does increasing energy efficiency impact environmental resources?

- A) It leads to resource depletion    B) It reduces energy consumption and waste  
C) It has no effect on resource use    D) It increases carbon emissions

### 12-What does an energy efficiency rating indicate?

- A) The amount of energy consumed    B) How much energy is wasted  
C) The effectiveness of energy use    D) The lifespan of the appliance

### 13-In thermodynamics, what is meant by "internal energy"?

- A) Energy from external sources    B) The total energy contained within a system  
C) Energy lost to the environment    D) Energy from chemical reactions only



**14-What is an example of an endothermic reaction?**

- A) Burning wood    B) Baking bread    C) Melting ice    D) Respiration

**15-How does the efficiency of energy transformation affect ecosystems?**

- A) It decreases biodiversity    B) It increases energy availability  
C) It has no impact on ecosystems    D) It leads to habitat destruction

**16-Which of the following would be classified as a closed system?**

- A) A pot of boiling water with an open lid    B) A sealed pressure cooker  
C) An open flask of acid    D) A greenhouse

**17-What happens to energy as it moves up the food chain?**

- A) It is completely converted to heat    B) It increases at each trophic level  
C) It decreases due to inefficiencies    D) It is stored indefinitely

**18-Which of the following processes releases energy?**

- A) Photosynthesis    B) Melting of ice  
C) Combustion of fossil fuels    D) Dissolving salt in water

**19-What is the significance of the energy pyramid in ecosystems?**

- A) It shows energy flow and efficiency    B) It represents population sizes  
C) It indicates biodiversity levels    D) It tracks species extinction rates

**20-Which is a major source of renewable energy?**

- A) Natural gas    B) Coal    C) Solar energy    D) Petroleum

**21-What does the term "entropy" refer to in thermodynamics?**

- A) Energy conservation    B) Measure of disorder  
C) Energy efficiency    D) Chemical stability

**22-How can individuals contribute to energy conservation?**

- A) Using more electrical appliances    B) Turning off unused lights  
C) Ignoring energy-efficient products    D) Increasing water usage

**23-Which of the following is NOT a property of an isolated system?**

- A) No energy exchange    B) No matter exchange  
C) Constant internal energy    D) Interaction with surroundings

**24-In terms of energy efficiency, what is the best practice for heating water?**

- A) Using an electric kettle    B) Boiling water on a stove  
C) Using a microwave    D) Heating water in a solar heater

**25-What is the role of decomposers in energy flow?**

- A) They produce energy    B) They consume energy only  
C) They recycle nutrients and energy    D) They compete with primary producers

**26-What type of energy is primarily harnessed during photosynthesis?**

- A) Thermal energy    B) Mechanical energy  
C) Light energy    D) Chemical energy

**27-What does "heat capacity" refer to?**

- A) The total energy in a system    B) The ability to absorb heat  
C) The mass of a substance    D) The temperature of a substance



**28-Which of the following is a practical example of energy conservation?**

- A) Leaving lights on when not in use
- B) Using LED bulbs instead of incandescent bulbs
- C) Ignoring energy labels on appliances
- D) Increasing car travel

**29-What is the relationship between energy efficiency and greenhouse gas emissions?**

- A) Higher efficiency leads to higher emissions
- B) Lower efficiency reduces emissions
- C) Higher efficiency reduces emissions
- D) There is no relationship

**30-What happens during an isothermal process?**

- A) Temperature changes
- B) Energy is conserved
- C) Internal energy remains constant
- D) Heat is absorbed only





## Lesson Three Food and ecosystems health

The health of ecosystems depends on a certain balance of nutrients, which cycle through nature in complex ways.

How these cycles work and how human activities affect them. By understanding the role of nutrients in ecosystems, you can learn how human activity can affect the environment and how to keep it in balance

In ecosystems, nutrients act as essential elements that support the life of native organisms, essential for the growth, development and health of plants and animals, and play a vital role in biological processes.

These elements include carbon, nitrogen, and phosphorus, each of which plays a specific role in supporting ecosystems.

### ➤ Types of main nutrient elements

#### A. Carbon (C)

Carbon is the basic element in all organic compounds, such as proteins, carbohydrates, fats and nucleic acids (DNA-RNA).

1. Carbon is also found in the atmosphere in the form of carbon dioxide gas  $\text{CO}_2$ .

2. It is also found in compounds that make up the bodies of living organisms

3. In the soil within organic matter and humus

4. In the hydrosphere in the form of carbonate and bicarbonates salts ( $\text{CO}_3^{2-}$ ,  $\text{HCO}_3^-$ ) dissolved in water

5. In the lithosphere in the limestone rocks  $\text{CaCO}_3$ , in dolomite rock  $\text{CaMg}(\text{CO}_3)_2$  and in hydrocarbons, coal, oil and natural gas.

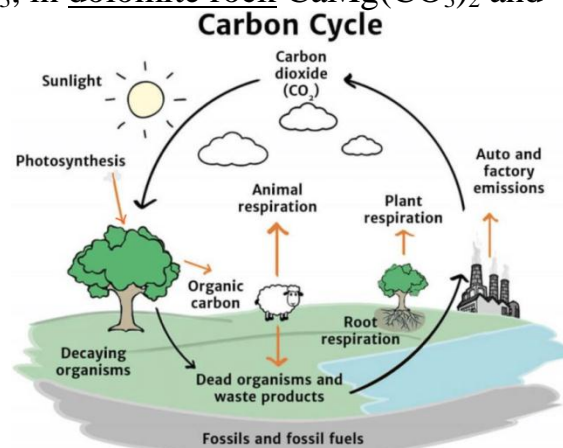
#### Carbon cycle:

It is a continuous bio-geological process in which the carbon element is exchanged between living organisms, atmosphere, oceans and rocks.

a. The carbon cycle begins with plants take  $\text{CO}_2$  from the atmosphere in the process of photosynthesis to produce organic compounds.

In plants also the respiration process is carried out and this results in  $\text{CO}_2$  gas, which returns to the atmosphere and is then used in the process of photosynthesis so that the cycle is completed by returning it to the plant

b. When herbivorous animals feed on the plant, the organic substances containing carbon contribute to the construction of organic tissues, and therefore the carbon atoms in the plant become part of the structure of the animal body that feeds on them.





## What happens to carbon next?

**1. Part of the carbon** in the cells and the tissues of the **organisms** are **returned to air through the respiration**, and **they** lose part through their secretions and wastes.

**After their death**, carbon is transferred to organic matter, then it return to the ground due to aerobic decomposition by the decomposing microorganisms.

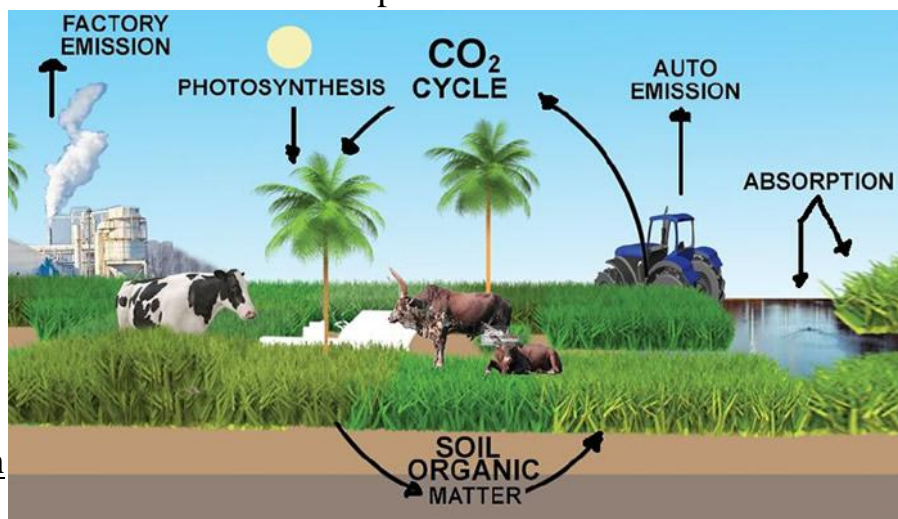
**2. In marine organisms**, carbon in the form of calcium carbonate is included in the composition of solid parts such as mollusk shells. After long periods of time, carbon is fixed in the rocks from the marine sediments of these shells.

**3. A large part of CO<sub>2</sub>** is also dissolved in seawater, oceans and lakes, leading to the deposition of limestone rocks.

**These rocks may undergo chemical weathering**, so that part of the carbon returns to the atmosphere in the form of CO<sub>2</sub>.

**4. Carbon can also become trapped in fossil-fueled organic compounds**. And at the combustion of this fuel, the carbon returns to the atmosphere in the form of carbon dioxide to be recycled again.

**The carbon cycle** is complex and interconnected that link the living organisms, the atmosphere, the oceans and the rocks. Understanding this cycle is essential to understanding climate changes and human impact on the environment.



## B. Nitrogen gas (N<sub>2</sub>)

Nitrogen is a essential component of **amino acids**, which make up **proteins**.

**Proteins** are essential for **growth** and **development**.

**Nitrogen** enters the ecosystem through nitrogen **fixed by bacteria**, and then travels through the food chain.

## Nitrogen cycle:

**1. After plants and animals death**, they are **decomposed** by certain **bacteria** and **fungi**. These microorganisms produce **ammonia** NH<sub>3</sub> from nitrogen compounds in dead organic matter and in the waste products of organisms secreted by animals

**2. Plants absorb some ammonia** and use it to **make proteins** and other **salts** necessary for life. Ammonia that is not absorbed by plants is converted into nitrate compounds (NO<sub>3</sub>)<sup>-</sup> by nitro bacteria.



There are two types of nitro bacteria,

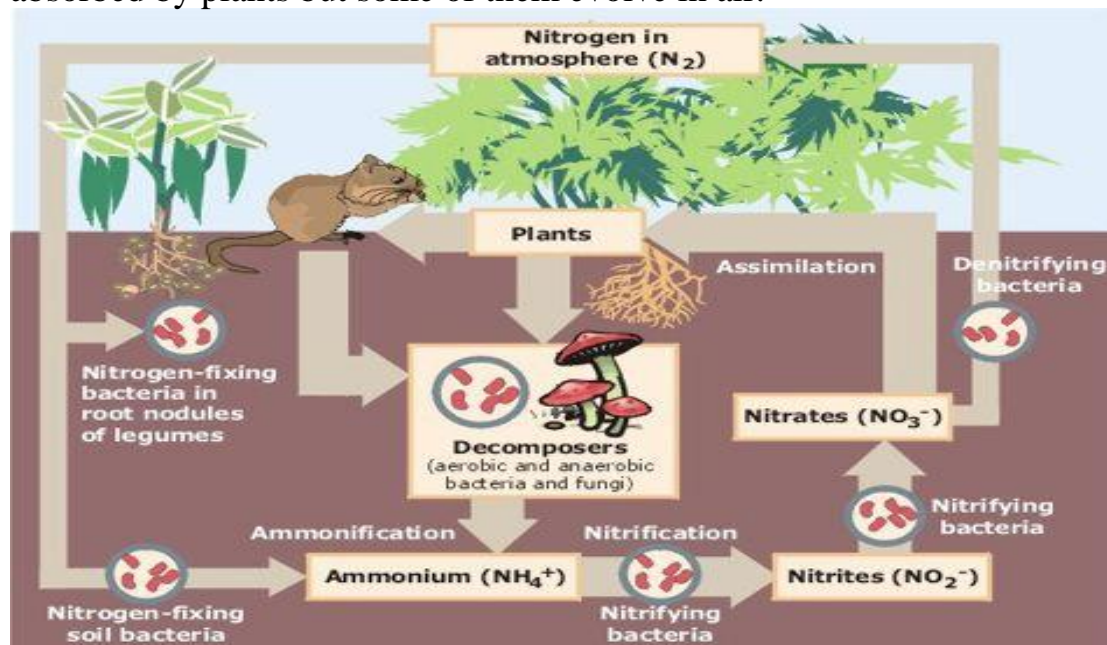
A-nitrite bacteria that changes ammonia into nitrite compounds ( $\text{NO}_2^-$ )

B-nitrate bacteria that changes nitrites into nitrates ( $\text{NO}_3^-$ )

- Plants absorb most of the nitrates and use them in the same way as ammonia.

Animals get nitrogen from eating plants or other animals that eat plants

3. The nitrogen fixation process adds more nitrogen in the biological cycle. Nitrogen fixation bacteria and algae get nitrogen from the air and convert it into ammonia absorbed by plants but some of them evolve in air.



Although nitrogen fixation takes nitrogen from air, there is an opposite process called Re-nitrogen.

Re-nitrogen bacteria convert some nitrates in the soil into gaseous nitrogen or nitrous oxide  $\text{N}_2\text{O}$ ,

But the constant nitrogen may rotate several times between the living organisms and the soil before returning to the air.

Some human activities hinder the nitrogen cycle.

For example, the industry consumes large amounts of nitrogen to produce fertilizers.

Despite the usefulness of fertilizers, the excess quantities of them seep from the agricultural land into the water, polluted it.





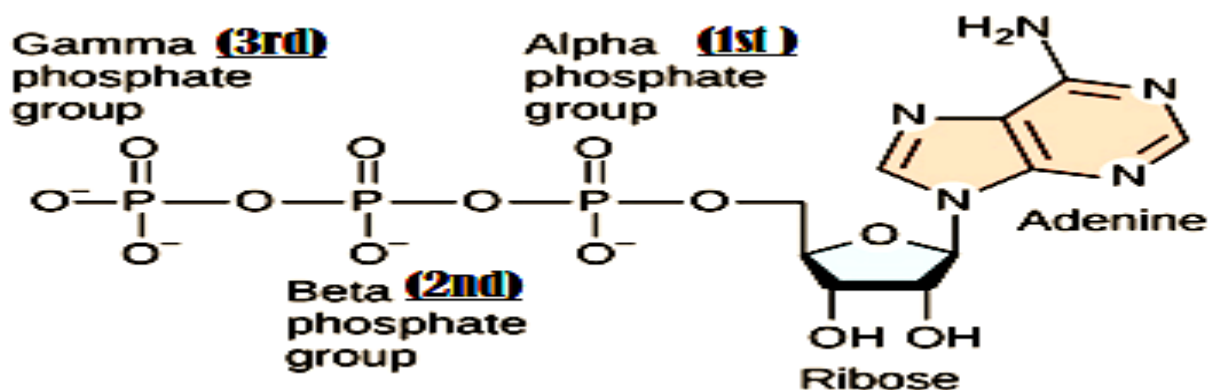
## C. Phosphorous (P)

1-Phosphorus plays an important role in the storage and transfer of energy in the cells through ATP (adenosine triphosphate).

2-Phosphorus contributes to the development of roots, flowers, and fruits, which affects plant productivity and synthesis of DNA and RNA.

Lack of nutrients such as nitrogen and phosphorus can lead to a weakening of plants and affect the health of the plants, leading to decreased productivity and increased diseases, which affects the ecosystem.

Nutrients such as carbon, nitrogen, and phosphorus are essential elements that support the life of plants and animals. By understanding the role of these nutrients, we can enhance healthy ecosystems and greater sustainability in the environment



### ➤ Impact of physical processes

Natural processes that contribute in the water cycle, also affect nutrient cycles.

When it rains, nutrients dissolved in water are transferred to the soil.

Evaporation, on the other hand, contributes to the transfer of water to the atmosphere, affecting the distribution of nutrients in the ecosystem.

The drought has a negative effect on the concentrations of organic carbon and nitrogen, where it has a positive effect on the concentration of inorganic phosphorus.

Drought can decrease vegetative cover that may encourage physical processes, such as rock erosion, at the expense of biological processes.







# Questions

## Multiple-Choice Questions

### 1-What is the primary role of carbon in ecosystems?

- a) Energy storage
- b) Oxygen production
- c) Building organic compounds
- d) Water retention

### 2-Which process do plants use to absorb carbon dioxide?

- a) Respiration
- b) Photosynthesis
- c) Transpiration
- d) Combustion

### 3-Which gas is produced during animal respiration?

- a) Oxygen
- b) Nitrogen
- c) Carbon dioxide
- d) Methane

### 4-What is nitrogen fixation?

- a) Conversion of ammonia to nitrate
- b) Conversion of atmospheric nitrogen into ammonia
- c) Release of nitrogen from decaying matter
- d) Uptake of nitrogen by plants

### 5-What is a significant source of nitrogen in agricultural soils?

- a) Fossil fuels
- b) Animal waste
- c) Rainwater
- d) Industrial emissions

### 6-Which organisms are primarily responsible for nitrogen fixation?

- a) Fungi
- b) Bacteria
- c) Plants
- d) Animals

### 7-What is the main use of phosphorus in plants?

- a) Photosynthesis
- b) Energy transfer
- c) Protein synthesis
- d) Respiration

### 8-How does excess nitrogen from fertilizers affect aquatic ecosystems?

- a) Increases biodiversity
- b) Promotes algal blooms
- c) Reduces oxygen levels
- d) Enhances plant growth

### 9-Which nutrient is most likely to cause water pollution in agricultural areas?

- a) Carbon
- b) Phosphorus
- c) Nitrogen
- d) Sulfur

### 10-What is a consequence of high nitrate levels in freshwater systems?

- a) Increased plant diversity
- b) Decreased dissolved oxygen
- c) Improved water clarity
- d) Enhanced fish health

### 11-Which nutrient cycle is primarily affected by human activity such as burning fossil fuels?

- a) Carbon cycle
- b) Nitrogen cycle
- c) Phosphorus cycle
- d) Water cycle

### 12-What role do decomposers play in nutrient cycles?

- a) Fix nitrogen
- b) Produce carbon dioxide
- c) Break down organic matter
- d) Absorb nutrients

### 13-Which of the following is a key component of ATP?

- a) Nitrogen
- b) Carbon
- c) Phosphorus
- d) Oxygen

### 14-What effect does drought have on nutrient cycling?

- a) Increases nutrient availability
- b) Reduces vegetation cover
- c) Enhances soil moisture
- d) Promotes photosynthesis



**15-Which process converts organic nitrogen back into atmospheric nitrogen?**

- a) Nitrification      b) Denitrification      c) Ammonification      d) Nitrogen fixation

**16-What is the primary source of phosphorus in ecosystems?**

- a) Atmospheric deposition      b) Soil minerals  
c) Organic waste      d) Industrial fertilizers

**17-Which of the following is a consequence of nutrient deficiencies in plants?**

- a) Increased growth      b) Enhanced reproduction  
c) Poor health and productivity      d) Greater resistance to pests

**18-How can human activities disrupt the nitrogen cycle?**

- a) By reducing nitrogen-fixing bacteria  
b) By increasing nitrogen input through fertilizers  
c) By promoting natural decomposition  
d) By enhancing plant absorption

**19-What happens during aerobic decomposition?**

- a) Produces methane      b) Consumes oxygen  
c) Increases carbon storage      d) Decreases nutrient availability

**20-Which nutrient is often a limiting factor in freshwater ecosystems?**

- a) Nitrogen      b) Carbon      c) Phosphorus      d) Sulfur

**21-How does precipitation affect nutrient cycles?**

- a) Increases soil nutrient loss      b) Transfers nutrients from soil to water  
c) Enhances plant growth      d) Decreases nutrient availability

**22-Which reaction is part of the carbon cycle?**

- a) Nitrogen fixation      b) Photosynthesis      c) Denitrification      d) Phosphorylation

**23-What is the term for the process where plants and animals release nutrients back into the soil?**

- a) Excretion      b) Decomposition      c) Mineralization      d) Respiration

**24-Which of the following is a natural source of nitrogen?**

- a) Fertilizers      b) Lightning      c) Industrial emissions      d) Wastewater

**25-How do aquatic plants obtain nitrogen?**

- a) From the soil      b) Through atmospheric absorption  
c) By consuming other organisms      d) From dissolved nitrates in water

**26-What is the main form of phosphorus available to plants?**

- a) Phosphate ( $\text{PO}_4^{3-}$ )      b) Phosphine ( $\text{PH}_3$ )  
c) Organic phosphorus      d) Elemental phosphorus

**27-What can be a long-term consequence of nitrate pollution?**

- a) Increased fish populations      b) Biodiversity loss  
c) Enhanced aquatic plant growth      d) Improved water quality

**28-Which type of bacteria converts ammonia into nitrites?**

- a) Denitrifying bacteria      b) Nitrifying bacteria  
c) Nitrogen-fixing bacteria      d) Decomposing bacteria



**29-Which nutrient is primarily involved in the synthesis of DNA and RNA?**

- a) Carbon      b) Nitrogen      c) Phosphorus      d) Sulfur

**30-What happens to carbon during combustion of fossil fuels?**

- a) It is stored in the soil      b) It is released as carbon dioxide  
c) It is absorbed by plants      d) It becomes part of the water cycle

**31-What is the impact of agricultural runoff on water quality?**

- a) Reduces nutrient levels      b) Increases sedimentation  
c) Introduces excess nutrients      d) Enhances aquatic biodiversity

**32-Which physical process can contribute to nutrient loss from soil?**

- a) Evaporation      b) Photosynthesis      c) Erosion      d) Transpiration

**33-What is the relationship between dissolved oxygen levels and aquatic health?**

- a) Higher levels support healthier ecosystems      b) Lower levels promote biodiversity  
c) Oxygen is not a factor in aquatic health      d) Excess oxygen harms aquatic plants

**34-What is the primary method by which nitrogen enters the ecosystem?**

- a) Weathering of rocks      b) Photosynthesis  
c) Nitrogen fixation      d) Evaporation

**35-What is a negative effect of algal blooms in freshwater systems?**

- a) Increased biodiversity      b) Enhanced oxygen levels  
c) Decreased light penetration      d) Improved water clarity

**36-Which nutrient cycle is most affected by deforestation?**

- a) Carbon cycle      b) Nitrogen cycle      c) Phosphorus cycle      d) Water cycle

**37-What role does humus play in nutrient cycling?**

- a) It prevents nutrient loss      b) It stores carbon  
c) It enhances soil structure      d) All of the above

**38-How can overuse of fertilizers impact the nitrogen cycle?**

- a) Increases biodiversity      b) Promotes nitrogen fixation  
c) Causes nutrient runoff      d) Enhances soil fertility

**39-What is the primary source of carbon in the atmosphere?**

- a) Ocean evaporation      b) Photosynthesis  
c) Respiration and combustion      d) Soil decomposition

**40-How does sedimentation affect nutrient availability in aquatic systems?**

- a) Increases nutrient levels      b) Reduces nutrient levels  
c) Has no effect      d) Enhances photosynthesis



## Second axis Energy and natural Resources

### Chapter two

### Renewable and non-renewable energy

### Lesson One Non-renewable energy resources

Energy runs the life, and the word energy is used in different fields in our daily conversation, for example, some commercials display types of food as sources of energy, athletes use the word energy in their talk about exercise, and companies that provide us with electricity, natural gas, fuel, etc. are called energy companies. However, scientists and engineers use the word energy more specifically. As I learned earlier that:

**Energy** is the ability to do work or make a change.

**The energy** is neither destroyed, nor created from nothing but it is transformed from one form to another form

Modern life depend heavily on energy sources that

1-warm our homes 2- power our cars, 3- provide us with electricity.

Most of this energy comes from non-renewable sources such as coal, oil and natural gas.

#### ➤ Forms of energy:

The natural sciences have been concerned for centuries with the study of matter and energy as fundamental concepts.

-**Energy has many forms**; each form can be transformed into another.

1-The light and the heat of the sun, 2-chemical energy, 3- nuclear energy, 4-electrical energy, 5-mechanical energy, and others, are forms of energy.

#### Ω Energy Sources

##### Non-renewable energy sources

Energy sources that are extracted from the ground and take millions of years to form, which means that they are used faster than they can regenerate.

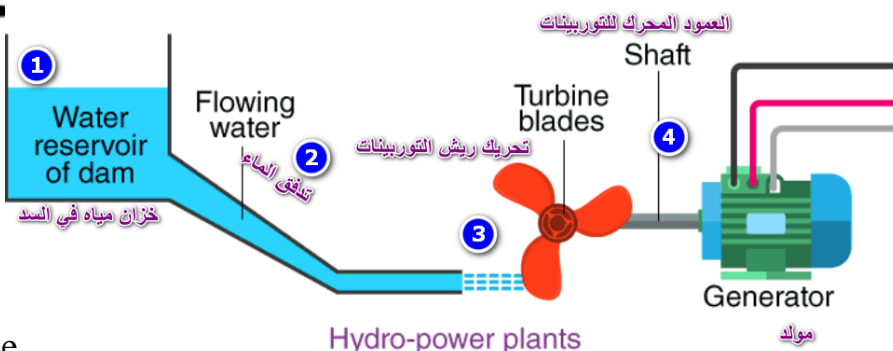
When these resources are exhausted, they can't be replaced quickly enough to meet human needs.



**The figure shows** a model of a hydroelectric power station.

Explore four forms of energy arranged in order of their transformations. Determine the output energy of the station.

Common examples of such exports include coal, oil, and natural gas.



Hydro-power plants

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1. Oil (Petroleum)	2. Coal	3. Natural gas
A mixture of <u>hydrocarbons</u> extracted <u>from deep earth</u> ,	A fossil fuel consisting of <u>decomposed plant residues</u> <u>since millions of years</u> and extracted from the mine.	A mixture of flammable gases extracted from the ground.
<p><b>Uses</b></p> <p>a. Its derivatives are used in the operation of cars, aircraft, and factories</p> <p>b. In the manufacture of plastics and chemical products.</p>	<p><b>Uses</b></p> <p>It is mainly used to generate electricity and operate factories.</p>	<p><b>Uses</b></p> <p>It is mainly used in cooking, heating houses, and generating electricity.</p>
<p><b>Harms</b></p> <p>The combustion of oil leads to the emission of greenhouse gases such as CO<sub>2</sub>, which contributes to the phenomenon of global warming and climate change.</p>	<p><b>Harms</b></p> <p>Coal emits great amounts of carbon dioxide and sulfur, contributes to climate change and air pollution.</p>	<p><b>Harms</b></p> <p>Although it is cleaner than oil and coal, its combustion emits carbon dioxide and water</p>
<p><b>Example</b> Oil spillage from oil tankers causes a threat to marine life and leads to significant pollution in oceans</p>	<p><b>Example</b> Open coal mines can destroy natural habitats and contribute to extinction of some plant and animal species.</p>	<p><b>Example</b> Serious leaks from gas pipelines may pollute the environment and increase the risk of explosions</p>



**Most important air pollutants produced from the fossil fuel burning:**

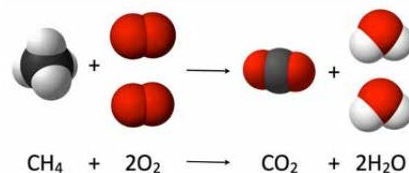




## A) Carbon dioxide CO<sub>2</sub>

When hydrocarbons (the main component of fossil fuels) are burned, the carbon and hydrogen in the fuel react with oxygen in the air to produce carbon dioxide and water

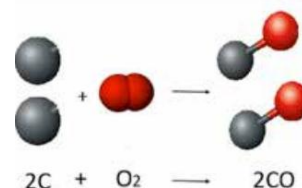
Example: Burning of methane



## B) Carbon monoxide CO

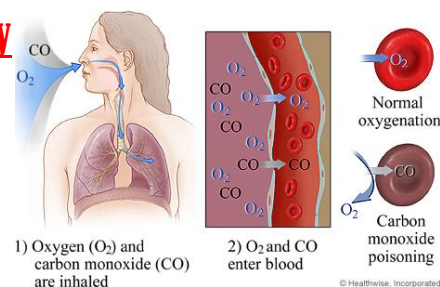
A colorless, odorless and tasteless toxic gas

- It is produced from the incomplete combustion of wood, gasoline, coal, natural gas and kerosene



## The effect of carbon monoxide gas on the human body

The gas spreads inside the blood by inhaling it and makes it difficult to bind the blood to oxygen gas, as the hemoglobin ability to bind to carbon monoxide gas is 210 times more than its ability to bind to oxygen, which leads to the destruction of red blood cells



### Symptoms:

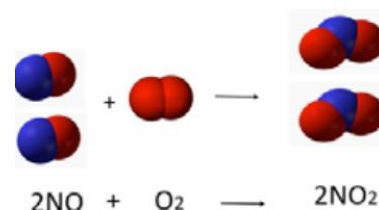
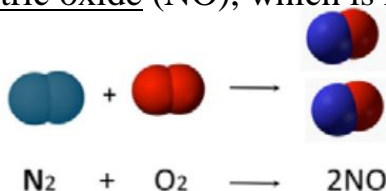
1-Difficulty breathing, 2-fatigue, 3-dizziness, 4-muscle relaxation 5- eventually death.

## C) Nitrogen oxides NO<sub>x</sub>

They are formed due to combustion of fuel at high temperatures, where nitrogenous impurities in the fuel react with air oxygen to form nitrogen oxides (NO, NO<sub>2</sub>)

### 1. Nitric oxide (NO)

In cars engines, the reaction of nitrogenous impurities and oxygen occurs in the combustion chamber to form nitric oxide (NO), which is really oxidized in air to form nitrogen dioxide (NO<sub>2</sub>).



### 2. Nitrogen dioxide (NO<sub>2</sub>)

All types of nitrogen oxides are toxic and harmful.

This gas can cause eye and respiratory irritation,

While exposing to it for long time leads to cardiovascular or pulmonary diseases.

Residents of urban areas are at greater risk from inhaling nitrogen oxide gases.





## The electric power stations:

The process of power generation depends on the first law of thermodynamics. In the power stations, the chemical energy stored in fossil fuels is converted into electrical energy.

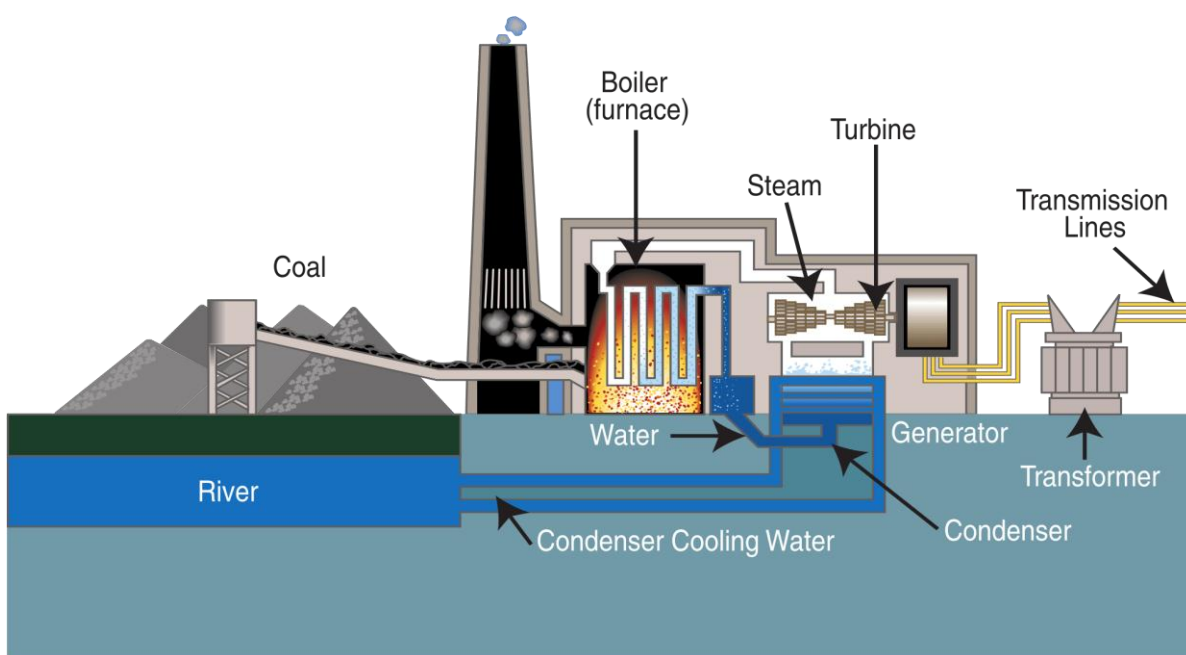
### **Disadvantages of this process**

1. A large amount of fossil fuel stocks is consumed
2. It produces a huge amount of gases, especially carbon dioxide, which has a main role in the continuous rise in the Earth temperature causing the global warming.

## The mechanism of work of the power plant:

1. Within the station, coal, petroleum or natural gas is combusted
2. The chemical energy turns into thermal energy used to heat water and transform it into steam,
3. The steam moves through pipes directing it to the turbines
4. The turbines begin to rotate under the effect of steam pressure and convert the kinetic energy into electrical energy

- It is noteworthy that a large amount of energy is lost in the form of carbon dioxide or in the form of leakage of part of the thermal energy through the pipes.





# Questions

## Multiple-Choice Questions

### 1-What is the primary characteristic of non-renewable energy sources?

- a) They are abundant and widely available.      b) They can be replenished quickly.  
c) They take millions of years to form.              d) They produce no greenhouse gases.

### 2-Which of the following is a non-renewable energy source?

- a) Solar energy      b) Wind energy      c) Coal      d) Biomass

### 3-What is the main component of crude oil?

- a) Water      b) Hydrocarbons      c) Carbon dioxide      d) Nitrogen

### 4-Which fossil fuel is primarily used for electricity generation?

- a) Natural gas      b) Coal      c) Oil      d) Biomass

### 5-What are the environmental impacts of burning coal?

- a) Produces clean air                                      b) Releases sulfur and carbon dioxide  
c) Increases biodiversity                                d) Decreases acid rain

### 6-What harmful gas is produced from incomplete combustion of fossil fuels?

- a) Carbon dioxide      b) Nitrogen      c) Carbon monoxide      d) Methane

### 7-How does natural gas compare to coal and oil in terms of pollution?

- a) It is more polluting                                      b) It is less polluting.  
c) It produces no emissions.                              d) It is equally polluting.

### 8-What is a major environmental risk associated with oil spills?

- a) Increased biodiversity                                b) Marine life pollution  
c) Soil enrichment                                      d) Clean water sources

### 9-Which of the following gases contributes to global warming?

- a) Nitrogen      b) Oxygen      c) Carbon dioxide      d) Hydrogen

### 10-What is the process of converting fossil fuels into electricity called?

- a) Thermal conversion                                      b) Chemical synthesis  
c) Electrical transformation                                d) Energy recycling

### 11-What is the main use of natural gas in households?

- a) Lighting      b) Cooking and heating      c) Cooling      d) Refrigeration

### 12-Which gas is mainly responsible for acid rain?

- a) Carbon monoxide      b) Methane      c) Sulfur dioxide      d) Nitrogen dioxide

### 13-What is the main byproduct of burning hydrocarbons?

- a) Oxygen      b) Carbon dioxide      c) Nitrogen      d) Hydrogen

### 14-What impact does coal mining have on the environment?

- a) Increases forest cover                                      b) Destroys natural habitats  
c) Improves soil quality                                      d) Reduces carbon emissions

### 15-Which of the following is a common pollutant from vehicle emissions?

- a) Carbon dioxide      b) Hydrogen      c) Oxygen      d) Argon

### 16-What is the main environmental concern with natural gas extraction?

- a) Oil spills      b) Water contamination      c) Deforestation      d) Soil erosion





**17-How does burning fossil fuels contribute to climate change?**

- a) By releasing oxygen
- b) By increasing greenhouse gases
- c) By reducing solar radiation
- d) By promoting photosynthesis

**18-What is the role of a power plant?**

- a) To extract fossil fuels
- b) To convert energy into mechanical work
- c) To convert thermal energy into electrical energy
- d) To store renewable energy

**19-What is a significant source of nitrogen oxides (NOx) emissions?**

- a) Industrial processes
- b) Natural gas burning
- c) Coal combustion
- d) All of the above

**20-Which of the following is a consequence of carbon monoxide exposure?**

- a) Improved oxygen transport in blood
- b) Difficulty breathing
- c) Increased energy levels
- d) Enhanced cognitive function

**21-What is the primary method of transporting oil?**

- a) Pipelines
- b) Electricity
- c) Wind turbines
- d) Solar panels

**22-What is the main chemical reaction that occurs when fossil fuels are burned?**

- a) Combustion
- b) Photosynthesis
- c) Fermentation
- d) Oxidation

**23-Which fossil fuel is primarily used for heating in homes?**

- a) Coal
- b) Oil
- c) Natural gas
- d) Biomass

**24-What is the primary pollutant from burning coal?**

- a) Methane
- b) Carbon monoxide
- c) Sulfur dioxide
- d) Nitrogen dioxide

**25-How do sulfur oxides (SO<sub>x</sub>) impact the environment?**

- a) Promote plant growth
- b) Contribute to acid rain
- c) Reduce air pollution
- d) Increase oxygen levels

**26-What is the main greenhouse gas emitted from fossil fuel combustion?**

- a) Nitrogen
- b) Carbon dioxide
- c) Methane
- d) Ozone

**27-Which of the following fuels is the cleanest burning?**

- a) Coal
- b) Oil
- c) Natural gas
- d) Biomass

**28-What is the main environmental effect of oil drilling?**

- a) Habitat destruction
- b) Increased biodiversity
- c) Soil enrichment
- d) Reduced emissions

**29-What can be a long-term consequence of relying on non-renewable energy sources?**

- a) Increased fossil fuel reserves
- b) Energy independence
- c) Climate change
- d) Cleaner air

**30-What type of energy transformation occurs in a thermal power plant?**

- a) Chemical to mechanical
- b) Thermal to electrical
- c) Mechanical to chemical
- d) Electrical to thermal

**31-What is a primary source of carbon dioxide emissions in urban areas?**

- a) Agriculture
- b) Fossil fuel combustion
- c) Deforestation
- d) Solar energy production

**32-Which fossil fuel is formed from ancient marine organisms?**

- a) Coal
- b) Natural gas
- c) Oil
- d) All of the above





**33-What is a major consequence of acid rain?**

- a) Improved crop yields
- b) Erosion of buildings
- c) Enhanced aquatic ecosystems
- d) Increased air quality

**34-How does coal combustion affect human health?**

- a) Decreases respiratory issues
- b) Increases air pollution and respiratory diseases
- c) Improves overall health
- d) Has no impact on health

**35-What is the primary use of petroleum products?**

- a) Agriculture
- b) Transportation
- c) Construction
- d) None of the above

**36-Which gas is produced when sulfur-containing fossil fuels are burned?**

- a) Nitrogen dioxide
- b) Hydrogen sulfide
- c) Sulfur dioxide
- d) Carbon monoxide

**37-What kind of energy transformation occurs when coal is burned to generate electricity?**

- a) Chemical to electrical
- b) Electrical to mechanical
- c) Thermal to chemical
- d) Mechanical to thermal

**38-What environmental issue is associated with hydraulic fracturing (fracking)?**

- a) Increased biodiversity
- b) Groundwater contamination
- c) Reduced air pollution
- d) Enhanced soil fertility

**39-What is the impact of fossil fuel combustion on global temperatures?**

- a) Decrease in temperatures
- b) No effect
- c) Increase in temperatures
- d) Stabilization of temperatures

**40-What product is derived from the combustion of methane?**

- a) Nitrogen oxides
- b) Carbon monoxide
- c) Carbon dioxide and water
- d) Sulfur dioxide



## Lesson Two Depletion of natural resources

**Depletion of natural resources** is the process of consuming natural resources at a faster rate than their ability to regenerate.

This includes fossil fuels, minerals, water, soil, and biodiversity.

This process affects ecosystems, public health and economies significantly, for example the mining process.

**Mining** is the process of searching and extracting of important minerals and the resources from the surface of the earth

Mining can cause a great harm to the environment, when natural resources are excessively extracted



**Mining or drilling wells have multiple physical effects such as:**

### 1. The change in the distribution of energy in the environment.

When minerals are extracted from the ground, soil layers are removed, affecting the exchange of heat and moisture in the soil, air, surface water and ground water.

Moist soil has a **greater ability to retain heat** for **longer periods** compared to dry soil.

This leads to changes in the thermal balance in the region.



**Impact of mining on soil.**

### 2. Compression and erosion:

Mining involve applying significant pressure to rocks and soil. This can lead to:

- a. Soil erosion and land degradation.
- b. It creates voids in the rock, which lead to collapse of the ground.

### 3. Changing the structure of the land.

Mining and digging operations remove the upper layers of soil and rock, which leads to land erosion and destruction of natural habitats.

This erosion can cause landslides and deterioration in soil quality.

### 4. Leakage of chemical substances into the global.

This pollution can change the physical properties of water, such as the degree of acidity and mineral concentrations, affecting the aquatic environment.



## Ω Chemistry and Mining:

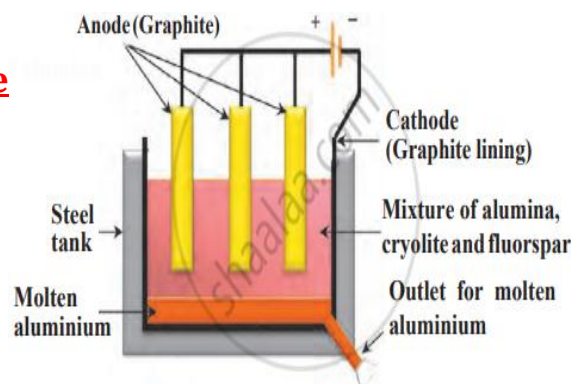
Chemistry is related to the processes of extraction, purification and use of minerals in various industries.

**a. Chemical analysis of ore:** before the mining process, the ore is analyzed using chemical techniques to determine the type of mineral and its quantity in the ore, which determines the feasibility of the mining process.

## b. Extraction of minerals:

### (1) Extraction of aluminum from bauxite ore using electrolysis

Aluminum is extracted from **bauxite ore**  $\text{Al}_2\text{O}_3$  dissolved in **cryolite**  $\text{Na}_3\text{AlF}_6$  by electrolysis process in the electrolytic cell shown in the figure



### (2) Extraction of gold using cyanide

Cyanide is used in gold extraction from its ores by dissolving it in an aqueous solution of sodium cyanide. Gold reacts with cyanide and oxygen to form a soluble compound of gold cyanide

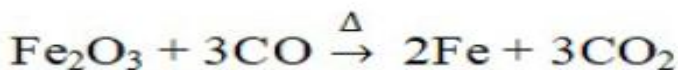
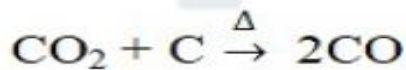
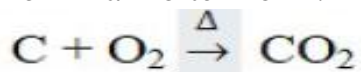


- Gold is then separated from the solution using activated carbon or through other processes.

### (3) Extraction of iron using hematite

a. Iron is extracted from hematite ore using coke, which reacts with a stream of oxygen, forming carbon dioxide

b.  $\text{CO}_2$  is reduced from carbon to carbon monoxide gas that acts as a reducing substance to extract iron in a molten form.





### c. Mineral purification

After some metals are extracted from their ores, the metals need purification processes, by electrolysis or by using chemical agents to purify the metals from impurities

## **Environment and Mining:**

Chemistry plays an important role in reducing the environmental impact of mining through the development of techniques to treat the contaminated water and safe disposal of wastes.

### Chemical waste disposal:

A process aimed at managing waste containing chemicals in a safe and effective manner to avoid environmental pollution and protect the health of human.

Given that they can be dangerous and toxic, their disposal requires careful procedures and strict regulatory standards.



### Steps of chemical waste disposal:

#### A) Classification and separation:

It must be classified the wastes according to its type and severity.

There are flammable waste, toxic waste, radioactive waste, and reactive waste. Each type of waste must be separated to ensure safe handling



#### B) Temporary storage:

- Chemical waste is stored in safe containers that are resistant to leakage and reaction.
- Clear warning labels should be placed on solutions indicating the type and danger of chemical substances.

#### C) Treatment:

- Chemical wastes may be subjected to special treatment to reduce their toxicity or to convert them into less hazardous substances.
- Chemical treatment methods include:
  1. Using of chemicals to neutralize acids or bases
  2. Using oxidation or reduction processes to break down toxic compounds.

#### D) Final disposal:

After treatment, wastes are disposed of in safe ways, such as





<u>1. Burial in private landfills</u>	<u>2. Burning in high-temperature furnaces</u>	<u>3. Recycling</u>
Waste is buried in special designed landfills to prevent the leakage of chemical substances into the soil or ground water. These burials are equipped with insulating layers and leak control systems.	Some chemical wastes can burn in special furnaces that reduce the volume of waste and eliminate its toxicity. These ovens operate at high temperatures to ensure that waste is decomposed completely.	Some chemical waste can be recycled and used again. For example, some chemical solvents can be purified and reused in other industrial processes.

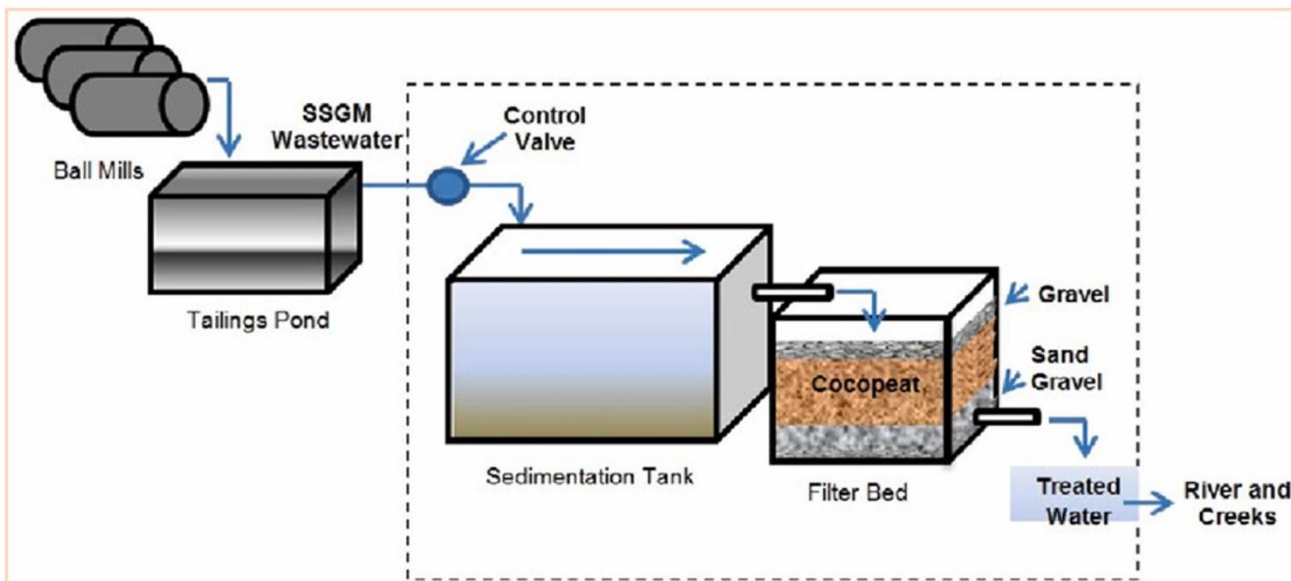
### Monitoring and follow-up:

After the disposal of chemical wastes, the sites of final disposal must be monitored to ensure that no leakage or contamination occurs.

Environmental standards and regulatory procedures must be followed to ensure compliance with laws and protect the environment.

### Example

Waste treatment from mining operations involves the use of methods such as chemical deposition or the use of filters to remove heavy metals from wastewater







# Questions

## Multiple-Choice Questions

### 1-What is natural resource depletion?

- a) The process of conserving resources
- b) Consuming resources faster than they can be replenished
- c) Increasing resource production
- d) None of the above

### 2-Which of the following is a common method of extracting minerals?

- a) Farming      b) Mining      c) Fishing      d) Recycling

### 3-What is a significant environmental impact of mining?

- a) Increase in biodiversity      b) Soil erosion and habitat destruction
- c) Improved air quality      d) None of the above

### 4-What happens to soil layers during mining?

- a) They become richer      b) They are removed
- c) They are preserved      d) They are strengthened

### 5-What is acid drainage?

- a) A process that enriches soil      b) The release of acidic water from mining sites
- c) A method of recycling water      d) None of the above

### 6-What physical effect does mining have on the environment?

- a) Decreased temperature      b) Change in energy distribution
- c) Increase in humidity      d) Reduction in pressure

### 7-What is a common chemical used in gold extraction?

- a) Sulfuric acid      b) Cyanide      c) Hydrochloric acid      d) Nitric acid

### 8-Which method is used to extract aluminum from bauxite?

- a) Distillation      b) Electrolysis      c) Filtration      d) Combustion

### 9-What is the primary purpose of chemical analysis before mining?

- a) To determine the aesthetic value of minerals
- b) To assess the feasibility of mining
- c) To predict weather patterns
- d) To evaluate soil health

### 10-Which process is involved in extracting iron from hematite?

- a) Electrolysis      b) Carbon reduction in a blast furnace
- c) Filtration      d) Distillation

### 11-What is the role of chemistry in mining?

- a) It has no role      b) It helps in the extraction and refining of minerals
- c) It only analyzes soil quality      d) It is only used in waste disposal

### 12-What is a potential consequence of mining operations on water quality?

- a) Improved pH levels      b) Contamination of groundwater
- c) Increased oxygen levels      d) Decreased mineral concentrations



**13-What type of waste is generated from mining?**

- a) Organic waste                      b) Chemical waste
- c) Non-toxic waste                  d) Biodegradable waste

**14-What is the first step in chemical waste disposal?**

- a) Monitoring sites                  b) Classification and separation
- c) Burning waste                      d) Final disposal

**15-What is one method for treating chemical waste?**

- a) Burial in regular landfills                  b) Chemical treatment
- c) Incineration without regulation              d) Open dumping

**16-Why is it important to monitor disposal sites for chemical waste?**

- a) To ensure waste is reused                  b) To prevent leakage and contamination
- c) To expand landfill capacity                  d) To increase waste production

**17-What can be an effect of deforestation on biodiversity?**

- a) Increased species diversity                  b) Loss of habitat and species extinction
- c) Improved ecosystem stability                  d) None of the above

**18-How does mining contribute to soil erosion?**

- a) By planting trees                      b) By removing vegetation and topsoil
- c) By enriching the soil                      d) By improving soil structure

**19-What chemical reaction occurs when fossil fuels are burned?**

- a) Combustion                  b) Fermentation                  c) Oxidation                  d) Distillation

**20-What is the main purpose of recycling chemical waste?**

- a) To increase toxicity                      b) To reduce waste volume
- c) To reuse hazardous materials                  d) All of the above

**21-What is a major risk of improper disposal of chemical waste?**

- a) Enhanced soil fertility                      b) Environmental pollution
- c) Increased biodiversity                      d) None of the above

**22-What happens during chemical precipitation in waste treatment?**

- a) Waste is burned                      b) Solids are separated from liquids
- c) Waste is buried                      d) Waste is recycled

**23-What is the primary goal of chemical waste disposal?**

- a) Economic profit                      b) Environmental protection
- c) Increased resource extraction                  d) Waste minimization

**24-Which mining process involves the use of a blast furnace?**

- a) Aluminum extraction                      b) Gold extraction
- c) Iron extraction                      d) Silver extraction

**25-What role does activated carbon play in gold extraction?**

- a) It burns the waste                      b) It absorbs gold from solution
- c) It enhances water quality                      d) It separates soil from minerals

**26-What effect does mining have on local ecosystems?**

- a) Enhances biodiversity                      b) Disrupts habitats
- c) Stabilizes soil                      d) Reduces pollution



**27-What is a common method to manage hazardous chemical waste?**

- a) Open dumping
- b) Incineration at high temperatures
- c) Mixing with non-hazardous waste
- d) Allowing it to degrade naturally

**28-What is an example of chemical waste?**

- a) Plastic bottles
- b) Organic food scraps
- c) Heavy metals from mining
- d) Paper products

**29-What happens to the pH of water contaminated by mining?**

- a) It remains neutral
- b) It becomes more alkaline
- c) It can become acidic
- d) It improves

**30-What is the environmental consequence of erosion caused by mining?**

- a) Increased soil fertility
- b) Loss of arable land
- c) More stable ecosystems
- d) None of the above

**31-Which of the following is a method of reducing mining waste?**

- a) Increasing extraction rates
- b) Recycling minerals
- c) Open-pit mining
- d) None of the above

**32-What is the main chemical used in the extraction of iron from hematite?**

- a) Cyanide
- b) Coke
- c) Sulfuric acid
- d) Sodium hydroxide

**33-How does resource depletion affect public health?**

- a) It has no effect
- b) It can lead to toxic exposure and health issues
- c) It improves overall health
- d) It increases access to clean water

**34-What is a potential long-term impact of mining on water resources?**

- a) Improved water quality
- b) Increased water availability
- c) Contamination of local aquifers
- d) None of the above

**35-What is the purpose of using filters in wastewater treatment from mining?**

- a) To increase waste volume
- b) To separate heavy metals
- c) To enhance chemical reactions
- d) To improve soil quality

**36-What is a common environmental regulation regarding chemical waste?**

- a) No regulations exist
- b) Waste can be disposed of anywhere
- c) Strict standards for disposal and treatment
- d) Regulations only apply to solid waste

**37-Which of the following is NOT a type of chemical waste?**

- a) Toxic waste
- b) Biodegradable waste
- c) Radioactive waste
- d) Flammable waste

**38-What can be a result of chemical runoff from mining sites?**

- a) Enhanced plant growth
- b) Water source contamination
- c) Improved soil quality
- d) Increased biodiversity

**39-What is the main function of a blast furnace?**

- a) To neutralize waste
- b) To convert iron ore into iron
- c) To recycle metals
- d) To extract oil

**40-What is one consequence of habitat destruction due to mining?**

- a) Increased species richness
- b) Loss of biodiversity
- c) Enhanced ecological balance
- d) None of the above

## Lesson Three

# Renewable energy

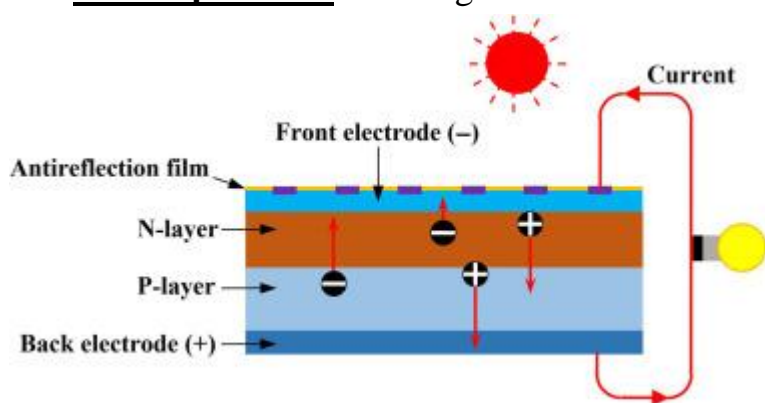
### Renewable energy sources:

#### 1. Solar energy

##### Solar cells:

They consist of semiconductors that convert solar energy directly into electrical energy.

- They are considered from the modern methods that **preserve the environment** and **reduce pollution** resulting from the use of fossil fuels in obtaining electrical energy.



1. When light falls on the surface of a semi-conductor material as silicon, photons of light shift electrons to one of their surfaces.
2. A potential difference is created between the two surfaces, which can create an electric current if connected to an external circuit.

##### - To determine the efficiency of solar cells,

we compare the electrical energy produced with the light energy provided by the sun. If the cell is able to convert all the light energy that falls on it into electrical energy, its efficiency is 100%.

In practical applications there are no ideal solar cells.

##### ☞ Factor affecting the efficiency of the solar cells

1. The angle of inclination of sun rays
2. Presence of clouds
3. Environmental factors as wind, humidity and dust

Science has recently developed techniques to improve the efficiency of solar cells, where the use of nanotechnology, in which materials have new distinctive properties on solar cells, which are characterized by a high ability to absorb sunlight to increase its efficiency.







➤ Electric energy (E) in joule is calculated from the relation:

$$E = V \times I \times t$$

Where,

E is the electric energy in joule (J)

V is the electric potential energy in volt (v)

I is the electric current intensity in ampere (A)

t is the time of passing the electric current in second (s)



➤ In practical applications, we deal with the power (P),

the produced or consumed energy per second and its measuring unit is watt (W)

**Power** is calculated from the relation:

$$P = I \times V$$

Electric power produced

$$\text{Electric cell efficiency} = \frac{\text{Electric power produced}}{\text{Solar power fall on the cell}} \times 100$$

- Example A Sheet of photo cell produces a potential difference of 10v and a current intensity 0.5A when a circuit connected to it is closed, calculate the electrical power it produces.

Solution

$$P = I \times V$$

$$P = 0.5 \times 10 = 5 \text{ watt (W)}$$

- Think: If you have a solar cell installed on the roof of a house. This solar cell works at 20% efficiency.



- 1.If sunlight provides 1000 W/m<sup>2</sup> of solar energy on the cell surface, how much electricity does solar cell produce per square meter?
2. If the solar cell area is 2 m<sup>2</sup>, what is the total electrical power produced by the sheets?
3. How can the production of electrical energy from the solar cell be increased?

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## 2. Wind energy

Wind energy is one of the most important environmentally friendly alternative energy sources that depend on converting wind energy into clean electrical energy. It relies in its work on the operating of wind turbines with air movement.

### It consists of:

1. Streamlined, curved blades or fans
2. Turbines
3. Generators.

When the air current flows on both sides of the fans, two areas with different atmospheric pressure are formed as a result of the difference in speed of air on both sides of the fans that leads to their movement

The blades (fans) are connected by means of a rod to transport the movement to the turbines connected to the generators in order to convert electrical energy into electrical energy.

- The efficiency of wind mills depends on the speed of wind movement in the region, so it is preferable to build them in open areas such as the desert, and high altitude areas.

## 3. Hydroelectric energy

Dams are used to store water in a reservoir, and thus water acquires potential energy due to its new position

The dam contains gates to control the movement of water. When the gates are opened, water flows from top to bottom in front of the dam to fall on turbines that rotate and this movement is transmitted to the generators that convert the kinetic energy into electrical energy.

## 4. Bioenergy

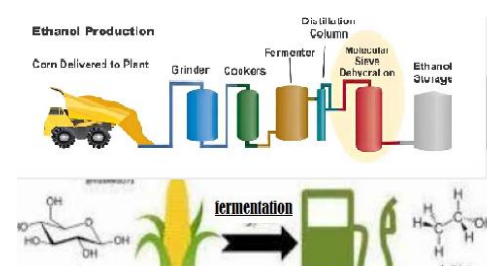
Bioenergy is produced from organic materials such as plants and animals.

These materials can be converted into biofuels, such as ethanol and biodiesel, or to electricity by burning them in electric power stations.

### For example

Crops as corn and sugar cane are used to produce ethanol that is used as a substitute for gasoline. Animals and agricultural residues can be used to convert them into energy through fermentation or burning.

Bio energy contributes to reducing carbon emissions compared to fossil fuels, as the carbon released during the combustion of bio-fuel to the atmosphere is absorbed by plants.





# Questions

## Multiple-Choice Questions

**1-What is the primary source of solar energy?**

- a) Wind      b) Sunlight      c) Water      d) Biomass

**2-Which component converts sunlight into electricity in solar panels?**

- a) Turbines      b) Photovoltaic cells      c) Generators      d) Batteries

**3-What percentage of sunlight does a solar cell operating at 20% efficiency convert into electricity?**

- a) 10%      b) 20%      c) 50%      d) 100%

**4-What is the main advantage of wind energy?**

- a) It requires a lot of water      b) It produces no carbon emissions  
c) It's always available      d) It is the cheapest form of energy

**5-Where are wind turbines most efficiently placed?**

- a) Urban areas      b) Forests  
c) Open plains and high altitudes      d) Coastal cities

**6-What energy conversion occurs in hydroelectric power plants?**

- a) Chemical to mechanical      b) Kinetic to electrical  
c) Thermal to electrical      d) Solar to kinetic

**7-What is bioenergy primarily derived from?**

- a) Fossil fuels      b) Organic matter  
c) Nuclear reactions      d) Geothermal sources

**8-Which of the following biofuels is produced from corn?**

- a) Biodiesel      b) Ethanol      c) Methanol      d) Propanol

**9-How do solar cells increase their efficiency?**

- a) Using larger panels      b) Utilizing nanotechnology  
c) Increasing temperature      d) Reducing size

**10-What is a disadvantage of wind energy?**

- a) It produces greenhouse gases      b) It is intermittent and depends on weather  
c) It is too expensive      d) It requires a lot of water

**11-What type of energy is generated by the movement of water in a dam?**

- a) Thermal energy      b) Mechanical energy  
c) Potential energy      d) Kinetic energy

**12-Which of the following renewable energy sources emits no carbon dioxide during operation?**

- a) Natural gas      b) Wind energy      c) Coal      d) Oil

**13-What is the role of turbines in a hydroelectric power plant?**

- a) To store water      b) To convert kinetic energy to electrical energy  
c) To filter water      d) To generate heat

**14-Which renewable energy source is considered the most variable?**

- a) Solar energy      b) Wind energy      c) Hydro energy      d) Geothermal energy



**15-What is the primary benefit of using biofuels compared to fossil fuels?**

- a) They are cheaper
- b) They are renewable and reduce carbon emissions
- c) They provide more energy
- d) They are more efficient

**16-Which of the following is a challenge associated with solar energy?**

- a) High operating costs
- b) Dependency on sunlight
- c) High carbon emissions
- d) Limited availability

**17-How does renewable energy contribute to combating climate change?**

- a) By increasing fossil fuel use
- b) By reducing greenhouse gas emissions
- c) By promoting chemical pollution
- d) By increasing resource consumption

**18-What is the main regulatory purpose regarding renewable energy installations?**

- a) To increase installation costs
- b) To ensure compliance with environmental laws
- c) To limit energy production
- d) To discourage investment

**19-Which renewable energy source relies on the Earth's internal heat?**

- a) Wind energy
- b) Solar energy
- c) Geothermal energy
- d) Bioenergy

**20-What is a common method to increase the efficiency of wind turbines?**

- a) Increasing blade length
- b) Reducing speed
- c) Using heavier materials
- d) Decreasing height

**21-Which factor does NOT affect solar panel efficiency?**

- a) Temperature
- b) Angle of sunlight
- c) Amount of rainfall
- d) Dust accumulation

**22-What is one way to manage the challenges of wind energy?**

- a) Building more fossil fuel plants
- b) Using energy storage systems
- c) Reducing installation size
- d) Limiting wind farm locations

**23-What is the 'greenhouse effect'?**

- a) A process that cools the Earth
- b) The warming of the Earth due to trapped gases
- c) A method of producing energy
- d) The conversion of solar energy

**24-What is the potential environmental impact of biofuels?**

- a) Increased carbon emissions
- b) Habitat destruction
- c) Enhanced biodiversity
- d) Lower water consumption

**25-What is the primary purpose of a dam in hydroelectric power generation?**

- a) To create recreational areas
- b) To store water and release it for power generation
- c) To filter pollutants from water
- d) To increase fish populations

**26-Which renewable energy source can be harnessed both on land and offshore?**

- a) Solar
- b) Wind
- c) Geothermal
- d) Bioenergy

**27-How does the use of solar energy help reduce chemical pollution?**

- a) By increasing fossil fuel reliance
- b) By reducing dependence on fossil fuels
- c) By increasing water usage
- d) By promoting chemical fertilizers

**28-What is a common use for geothermal energy?**

- a) Heating buildings
- b) Fueling cars
- c) Generating wind power
- d) Producing biofuels



**29-What is the main challenge of integrating renewable energy into existing power grids?**

- a) High installation costs      b) Inconsistent energy supply
- c) Lack of technology      d) Increased pollution

**30-Which of the following is a non-renewable energy source?**

- a) Solar      b) Coal      c) Wind      d) Biomass

**31-What is the main advantage of using wind energy compared to fossil fuels?**

- a) It is more reliable      b) It is less expensive to install
- c) It produces no emissions      d) It generates more energy

**32-What type of energy is produced when biomass is burned?**

- a) Chemical energy      b) Thermal energy      c) Electrical energy      d) Mechanical energy

**33-Which of the following is a risk associated with hydroelectric power?**

- a) Deforestation      b) Water scarcity      c) Soil erosion      d) All of the above

**34-What is one benefit of using energy storage systems with renewable energy?**

- a) They increase carbon emissions      b) They provide a consistent energy supply
- c) They reduce installation costs      d) They eliminate the need for renewable sources

**35-Which renewable energy source has the highest potential for energy generation worldwide?**

- a) Solar energy      b) Wind energy      c) Geothermal energy      d) Hydroelectric energy

**36-What is a common practice to improve solar energy efficiency?**

- a) Increasing the size of panels      b) Using tracking systems to follow the sun
- c) Reducing the number of panels      d) Installing in shaded areas

**37-Which of the following renewable sources is the most predictable?**

- a) Solar energy      b) Wind energy      c) Hydroelectric energy      d) Biomass

**38-What is the primary barrier to widespread adoption of renewable energy?**

- a) Lack of technology      b) High initial costs
- c) Insufficient resources      d) Regulatory challenges

**39-What is the carbon footprint of biofuels compared to fossil fuels?**

- a) Higher      b) Lower      c) The same      d) Unknown

**40-Which renewable energy source can be used to produce hydrogen fuel?**

- a) Solar energy      b) Wind energy
- c) Both a and b      d) None of the above





# Lesson Four Applications of renewable energy

مجال مبتكر

Using of living organisms in the production of renewable energy is an innovative field that combines the biology and technology to create sustainable energy sources. Renewable energy from living organisms depend on harnessing the natural biological processes that occur in these organisms. Research and development in this field continues to enhance our ability to harness natural resources in a way that preserves the environment and supports global energy aims.

## Renewable bioenergy sources

**1. Biomass** (agricultural waste, such as rice straw, or certain types of plants, such as sugar cane) can be used to produce energy through fermentation and aerobic decomposition processes.



**2. Minute algae and microbes** produce biofuels through biological processes (as convert organic materials into electrical energy or liquid fuels).



**3. Methane-producing bacteria** can be used to decompose the organic matters in waste treatment plants or animal pens to produce methane as biofuel.



**4. Specific enzymes** are used to convert cellulose found in plants into sugar, which can be converted into **ethanol** (a type of hydrocarbon fuel).

**5. Enzymes can be used to decompose fats** from biological sources such as vegetable oils or animal fats and convert them to **biodiesel** (biofuel)

**5. Minute algae** grow rapidly and convert light and organic materials into oils that can be converted into **biodiesel**.

- This type of fuel is a promising source because it does not need a large agricultural area and can grow in areas that are not suitable for agriculture.

**6. The plants** is a source of **renewable energy**, where plants are transformed through fermentation and decomposition of into biofuels

- Some aquatic plants, such as **Nile roses** or mosses, can be grown and used to produce **biodiesel** or **ethanol**.







Plants can be used to produce the bio- mass that can be converted to different types of bio fuels.

**7. Energy extracted from marine algae**, is an innovative source of renewable energy, as it can be converted into **biofuels** due to its ability to grow rapidly and use marine resources sustainably.



- These algae can grow in seawater and do not need for agricultural land.

**8. Photo-bacteria** use light to convert carbon dioxide and water into biofuel effectively and sustainably such as **ethanol** or **hydrogen**.

## The devices that work by solar energy in homes

### 1. Solar heaters

They are used to heat water in houses instead of the electric heaters thus reducing the use of electricity, which helps to save and reduce the value of the bill. These types of heaters are characterized with high efficiency and the possibility of using it throughout the year comfortably due to availability of the sun



### 2. Air conditioners

People in hot countries need air conditioners and cooling systems greatly.

Egypt is one of the places that are constantly exposed to sunlight, the option of air conditioners that work with solar energy is very suitable for the population, as its use reduces electric consumption



### 3. Solar lamps

Solar lamps can be used for **lighting**, **garden decoration** and are in case of **power outage**

- They are considered a **major alternative** to lighting and **consume less electricity**.

- **Solar lamps** work by placing them **under the sun's rays**, and include an automatic operation feature, in addition to being environmentally friendly and do not produce any exhaust





# Questions

## Multiple-Choice Questions

### 1-What is one key benefit of using solar water heaters?

- a) They increase electricity consumption
- b) They reduce reliance on electric heaters
- c) They produce carbon emissions
- d) They require constant maintenance

### 2-Which renewable energy source is commonly used to power air conditioning systems?

- a) Coal
- b) Natural gas
- c) Solar energy
- d) Nuclear energy

### 3-How do solar lights contribute to energy savings?

- a) They use fossil fuels
- b) They rely on battery storage
- c) They operate without electricity
- d) They require constant recharging

### 4-What is biomass primarily derived from?

- a) Fossil fuels
- b) Organic materials
- c) Minerals
- d) Nuclear waste

### 5-Which process is commonly used to convert agricultural waste into biofuel?

- a) Fermentation
- b) Combustion
- c) Distillation
- d) Filtration

### 6-What is one advantage of using microalgae for biofuel production?

- a) High land use
- b) Slow growth rate
- c) Ability to grow in non-arable land
- d) High carbon emissions

### 7-How do methane-producing bacteria contribute to renewable energy?

- a) They produce heat
- b) They generate electricity
- c) They produce methane from organic matter
- d) They consume fossil fuels

### 8-What is the primary role of enzymes in renewable energy production?

- a) To increase carbon emissions
- b) To accelerate chemical transformations



- c) To store energy
- d) To filter pollutants

**9-Which of the following is a type of biofuel produced from fats?**

- a) Ethanol
- b) Biodiesel
- c) Methanol
- d) Propanol

**10-Which renewable energy source uses light to convert carbon dioxide into biofuels?**

- a) Solar energy
- b) Wind energy
- c) Phototrophic bacteria
- d) Biomass

**11-What is a primary application of solar energy in homes?**

- a) Heating swimming pools
- b) Cooking food
- c) Lighting gardens
- d) Powering televisions

**12-How do solar panels help reduce chemical pollution?**

- a) By increasing water usage
- b) By reducing dependence on fossil fuels
- c) By emitting sulfur dioxide
- d) By improving soil quality

**13-Which of the following renewable energy sources does NOT produce carbon dioxide during power generation?**

- a) Natural gas      b) Wind energy      c) Coal      d) Oil

**14-What type of energy is produced from seaweed?**

- a) Solar energy      b) Geothermal energy
- c) Biofuel      d) Wind energy

**15-Which appliance can be powered by solar energy to enhance energy efficiency?**

- a) Electric oven      b) Solar heater
- c) Gas stove      d) Electric kettle

**16-What is a benefit of using solar-powered air conditioners?**

- a) Increased electricity bills
- b) Reduced energy consumption
- c) Higher carbon emissions
- d) Limited efficiency

**17-How do solar-powered garden lights operate?**

- a) By using batteries
- b) By relying on fossil fuels
- c) By converting sunlight into electricity
- d) By using chemical reactions



**18-Which of the following is a key challenge for biomass energy production?**

- a) High availability
- b) Land use competition
- c) Low energy yield
- d) Increased emissions

**19-What is the main purpose of using renewable energy technologies?**

- a) To increase fossil fuel dependence
- b) To reduce greenhouse gas emissions
- c) To limit energy production
- d) To raise energy costs

**20-Which type of biofuel is derived from the fermentation of sugars?**

- a) Ethanol
- b) Biodiesel
- c) Methanol
- d) Propanol

**21-What is a major advantage of using microalgae for biofuel production?**

- a) Requires large land areas
- b) Grows slowly
- c) Can be cultivated in seawater
- d) Produces high emissions

**22-How does solar energy help reduce energy bills in homes?**

- a) By increasing energy consumption
- b) By providing free energy from the sun
- c) By requiring expensive equipment
- d) By reducing the need for appliances

**23-What is the environmental benefit of using renewable energy sources?**

- a) Increased air pollution
- b) Decreased biodiversity
- c) Reduced carbon footprint
- d) Higher greenhouse gas emissions

**24-Which renewable energy source is often used in waste treatment plants?**

- a) Solar energy
- b) Bioenergy
- c) Wind energy
- d) Geothermal energy

**25-Which of the following is NOT a characteristic of renewable energy?**

- a) Sustainable
- b) Finite
- c) Low emissions
- d) Environmentally friendly



# Chapter Three Resources recycling and investment

## Lesson One Importance of resource recycling

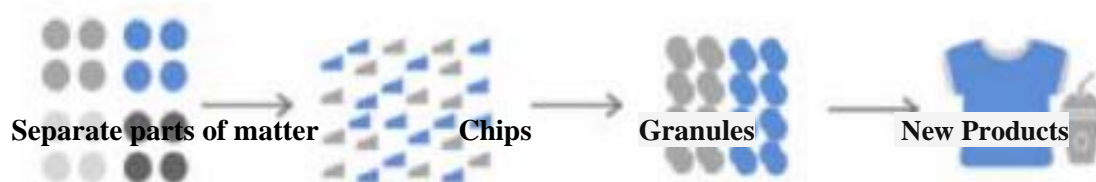
**Resource recycling** is the process of reusing materials that have already been used, turning them into new products instead of disposing of them as waste.

This process plays a vital role in achieving sustainable development, as it contributes to reducing pressure on natural resources and reducing environmental pollution.

### Types of recycling

#### 1. Mechanical cycling

The most common method in the world, in **which the non-decomposed residues** of the material are collected and **re-introduced back** into the same industry to go through the same stages of **manufacturing again** and form a product of the same type

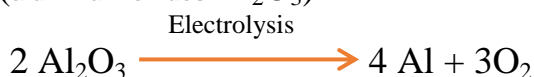


#### 2. Energy recycling

A method that is used only with the remnants of the plastic, where it is converted into electrical energy or thermal energy through the passage of the plastic through the process of burning to convert it into fuel

When recycling resources, we reuse the energy that was present in the primary materials instead of consuming new energy.

**Example Recycling aluminum** saves about 95% of the energy required to produce aluminum from bauxite (aluminum oxides  $\text{Al}_2\text{O}_3$ )



This process is carried out with electrolysis and requires high electrical energy.

In the recycling process, the consumed aluminum is simply remelted and reshaped, requiring much less energy.

**From the physical equation:**

**Saved energy = energy used in original production - energy used in recycling**

**Example:**

If the **production** of a ton of aluminum from a waste material requires **15,000 k Watt/h**,

-But **recycling** the same amount requires only **750 k Watt/h**.





**Note:**

Despite the significant benefits of energy cycling, negative aspects such as air pollution from waste burning should be taken into account. Therefore, more sustainable technologies for energy recycling must be developed.

### **3. Chemical recycling**

Chemicals are added to wastes to obtain basic materials, or used to decompose animal remains to obtain biogas

**Examples:**

**a. Electronic waste decomposition:** Chemical materials such as acids can be used to separate precious metals such as gold and copper from electronic waste.

**b. Expired drug decomposition:** Using acids or bases to break down expired medications into harmless compounds

### **4. Pyrolysis**

A chemical process occurs at high temperatures in the absence of oxygen, where organic waste is decomposed into simpler components such as gases, low-density liquids (such as bio oils) and solid substances.



### **5. Chemical Sterilization**

It involves the use of chemical reactions to neutralize toxic or harmful substances in wastes.

Examples:

**a. Neutralize of acids or bases:** In chemical wastes, acids or bases can be neutralized by anti-substances such as sodium carbonate or sodium hydroxide.

**Example:**



Hydrochloric acid reacts with sodium hydroxide to form sodium chloride (table salt) and water. This is a complete neutralization reaction that results in a neutral solution.

**b. Medical waste treatment:** Chemicals such as chlorine or ozone are used to treat medical waste to kill bacteria and viruses

### **6. Biochemical reactions:**

Using living organisms or enzymes to convert the organic wastes into fertilizers

**Examples**

**a. Bio-decomposition:**

Organic wastes such as food residues can be converted into organic fertilizers through chemical reactions with the help of microorganisms.

**b. Converting wastes into biofuels:**

Certain bacteria decompose organic wastes into biofuels such as ethanol.



**Chemical processes such as pyrolysis**, chemical decomposition, chemical sterilization, chemical recycling, and chemical bioreactivity are essential tools for converting waste into reusable resources.

These processes help reduce the volume of waste, reduce pollution, and turn unusable materials into useful resources.

### **Recycling Impacts Maintaining Environmental Balance:**

Recycling one ton of paper protects 17 trees and saves 70% of energy and 85% of water necessary for new paper production.

By recycling all newspapers, we can reduce carbon dioxide emissions by 20 million tons per year, which is equivalent to removing 5 million cars from the roads.

### **Sustainable City of the Future**

**Imagine living in the year 2050** in a city that relies entirely on renewable energy and advanced recycling of resources. In this city, no waste is sent to landfills and everything is recycled using the latest chemical and physical technologies. Factories use chemical recycling techniques to produce new materials from plastics, metals and glass, reducing the depletion of natural resources and limiting pollution.

**One of the biggest challenges** the city faces is dealing with the large amounts of plastic it uses, which is difficult to break down in nature. Using new technology to chemically break down plastic, the city is converting it back into its basic materials to produce new, reusable materials.

**You are part of a research team that is evaluating the efficiency and benefits of using chemical technology** to recycle plastics compared to conventional methods. The team is also working on developing new ways to improve the recycling of aluminum and glass using chemical technologies.



## Lesson one exercise

### 1-What is the basic process in resource recycling?

- a) Waste disposal      b) Reusing materials      c) Waste burning      d) Waste burial

### 2- Which of the following is an example of mechanical recycling?

- a) Burning plastic to produce energy      b) Reassembling plastic and converting it into new products  
c) Using acids to decompose waste      d) Analyzing biological waste to produce biogas

### 3- What type of energy is consumed in the production of aluminum from bauxite?

- a) Thermal energy      b) Electrical energy      c) Chemical energy      d) Mechanical energy

### 4-What is the approximate percentage of energy saved when recycling aluminum?

- a) 25%      b) 50%      c) 75%      d) 95%

### 5-Which of the following represents a drawback of energy recycling?

- a) Reduced energy consumption      b) Reduced air pollution  
c) Production of renewable energy      d) Increased air pollution

### 6- What is the process in which chemicals are used to convert waste into basic materials?

- a) Mechanical recycling      b) Energy recycling      c) Chemical recycling      d) Thermal decomposition

### 7-Which of the following is an example of using pyrolysis?

- a) Analyzing organic waste to produce biogas      b) Separating precious metals from electronic waste  
c) Burning plastic to produce energy      d) Recycling plastic into new products

### 8-Which of the following is an example of chemical sterilization of waste?

- a) Separating metals from electronic waste      b) Analyzing expired medications  
c) Neutralizing acids or bases in waste      d) Converting waste into fertilizer

### 9-What is the process that uses living organisms or enzymes to convert organic waste?

- a) Thermal decomposition      b) Biochemical reaction  
c) Chemical sterilization      d) Mechanical recycling

### 10-Which of the following is an example of biological decomposition?

- a) Converting plastic into fuel      b) Converting organic waste into fertilizer  
c) Converting waste into recyclable materials      d) Recycling metals

### 11- What is the purpose of using chemical processes in recycling plastic?

- a) To increase the volume of waste      b) To reduce pollution  
c) To convert plastic into recyclable materials      d) To increase waste treatment costs

### 12- Which of the following represents the importance of recycling resources in preserving biodiversity?

- a) Increasing air pollution      b) Reducing the need to extract resources  
c) Increasing land use      d) Increasing energy consumption

### 13-Which of the following represents a benefit of chemical recycling of plastic?

- a) Increasing harmful emissions      b) Reducing energy consumption  
c) The possibility of reusing plastic in new applications      d) Increasing the volume of waste

### 14-What is the process that uses a magnet to separate metals from waste?

- a) Electrostatic separation      b) Thermal decomposition  
c) Magnetic separation      d) Biochemical reaction



**15- What is the process that uses electrical charges to separate materials?**

- a) Magnetic separation                      b) Electrostatic separation
- c) Biological decomposition              d) Thermal decomposition

**16-What materials can be separated using electrostatic separation?**

- a) Only metals              b) Only plastic
- c) Metals and plastic              d) Organic waste

**17- What role does magnetic separation play in the automotive industry?**

- a) Separating precious metals                      b) Separating metals from other components
- c) Analyzing organic materials                      d) Converting waste into fertilizer

**18-What is the main condition for static electricity to occur?**

- a) Movement of electrical charges                      b) Balance of electrical charges
- c) Imbalance of electrical charges                      d) The presence of a magnetic field

**19-Which of the following is an example of generating static electricity by friction?**

- a) Connecting a wire to a power source              b) Touching a charged object with a neutral object
- c) Rubbing a balloon with your hair                      d) Approaching a charged object with a conductive object

**20-What is the process in which waste is heated in the absence of oxygen?**

- a) Biological decomposition                      b) Thermal decomposition
- c) Mechanical recycling                      d) Chemical recycling

**21- Why is the reprocessing process important in glass recycling?**

- a) Just for cleaning the glass
- b) Just to reduce the volume of glass
- c) To break down glass into its basic components and reuse them
- d) To convert glass into other non-recyclable materials

**22-How do resource recycling techniques contribute to reducing the environmental impact of resource extraction?**

- a) Increasing the need to extract resources                      b) Reducing the need to extract resources
- c) Not affecting resource extraction                      d) Increasing energy consumption in resource extraction

**23-What is the relationship between resource recycling and the circular economy?**

- a) Recycling conflicts with the circular economy
- b) Recycling is an essential part of the circular economy
- c) Recycling is not related to the circular economy
- d) Recycling leads to an increase in waste in the circular economy

**24- What are the challenges facing the widespread use of chemical recycling?**

- a) The ease of the process and its low cost
- b) The efficiency of the process and its ability to handle large quantities
- c) The high cost, difficulty of reusing by-products, and environmental impact
- d) The lack of need for by-products

**25- What is the importance of magnetic separation in the process of extracting metals?**

- a) Increase energy consumption
- b) Simplify the extraction process and increase output
- c) Increasing environmental pollution
- d) Increase extraction cost



### Essay Questions (5)

**1- Compare mechanical recycling and chemical recycling in terms of the processes used, benefits, and challenges.**

**2- Explain how magnetic and electrostatic separation contribute to reducing the depletion of natural resources and limiting environmental pollution.**

**3- Describe in detail the steps of the glass recycling process, and how chemical reactions contribute to this process.**

**4- Discuss the importance of resource recycling in maintaining biodiversity in ecosystems, and provide examples to support your answer.**

**5- What are the challenges facing plastic recycling, and how can chemical technology help overcome them?**

### Answer Keys

Multiple Choice Answers:

1. B 2. B 3. B 4.d 5.d 6. c 7. a 8. c 9. B 10. b 11.c 12.b 13.c 14.c 15.b  
16.c 17.b 18.c 19.c 20.b 21.c 22.b 23.b 24.c 25.b

### Essay Question Answers:

#### 1- Comparison of Mechanical and Chemical Recycling:

**Mechanical Recycling:** Relies on physical processes like collection, sorting, and grinding to recycle materials without altering their chemical composition. Benefits include ease of implementation and low cost, but challenges lie in the quality of recycled materials and the limited range of applications.

**Chemical Recycling:** Involves using chemical substances to break down waste into its basic components or convert it into other valuable materials. Benefits include the ability to obtain high-quality materials and expand the range of recyclable materials, but challenges include high cost and the potential environmental impact of the chemical substances used.

#### 2- Contribution of Magnetic and Electrostatic Separation:

**Magnetic Separation:** Uses strong magnets to separate metals from waste, which reduces the extraction of new metals and limits the environmental impact of mining.

**Electrostatic Separation:** Uses electrical charges to separate different materials, which contributes to separating plastics and glass and reduces the need to produce these materials from primary sources.

#### 3- Glass Recycling Process:

**Collection and Sorting:** Used glass is collected and sorted by color and type.

**Crushing and Cleaning:** The glass is crushed into small pieces and cleaned to remove impurities.

**Melting:** The glass is melted in special furnaces to produce molten glass.

**Shaping:** The molten glass is shaped into new products.

**4- Role of Chemical Reactions:** Chemical reactions are used to decompose glass into its basic components such as silica, and to reuse them in the manufacture of glass.

#### 5- Importance of Recycling in Preserving Biodiversity:

**Reduced Resource Extraction:** Recycling reduces the need for mining and logging, which preserves habitats and reduces the loss of biodiversity.

**Reduced Pollution:** Recycling reduces pollution from industries and extraction, which maintains the health of ecosystems and the life of living organisms.

**Examples:** Recycling paper reduces logging, and recycling plastic reduces ocean pollution.

**Challenges of Plastic Recycling and the Role of Chemical Technology:**

**Challenges:** Difficult decomposition, large diversity of plastic types, high cost.

**Role of Chemical Technology:** It can convert plastic into basic materials or transform it into valuable new materials, and reduce harmful emissions. It can also help in analyzing plastic into its primary components, making it easier to reuse.





# Lesson Two Resource recycling techniques and their impact on the environment

## Modern technologies in resource recycling:

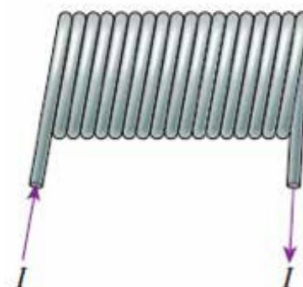
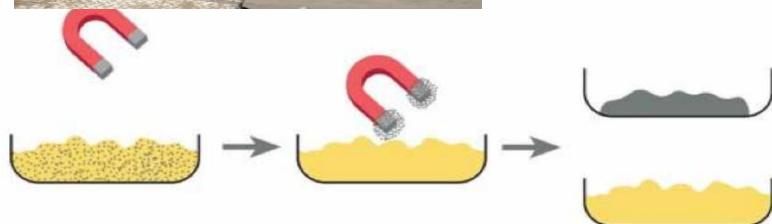
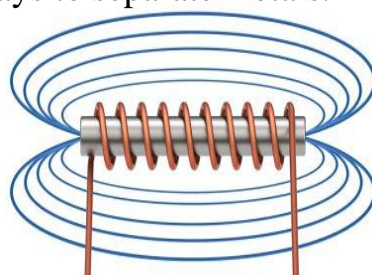
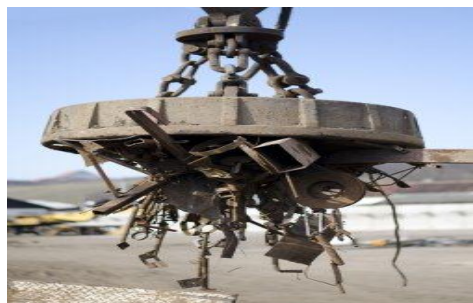
These depend on using advanced **chemical** and **physical** processes to **convert waste into reusable materials**. This contributes to **reducing the depletion of natural resources and reducing environmental pollution**.

These innovations contribute to sustainability and a circular economy.

### A) Magnetic separation:

The idea of magnetic separation depends on passing of a strong electromagnet on the remnants of metals in the factory.

When a large electric current passes in a coil, it turns into a temporary magnet that attracts magnetic materials around it and separates them from other materials, and this method is considered one of the effective ways to separate metals.



## Structure and work of the electromagnet

1. A coil of a wire made of copper with a large number of turns

2. The coil wrapped around a rod of wrought iron

When the two ends of the coil are connected to an electrical source and the electric current passes, and a magnetic flux is generated inside the coil, which works to convert the rod into a magnet

☞ The magnetic field strength depends on

1. The number of coil turns
2. The intensity of the electric current
3. The type of the iron rod.



## **Magnetic separation applications and their role in energy recycling:**

### **1. Recycling**

It can separate metals from residues and waste based on their magnetic capacity. This promotes the sustainable use of resources and reduces the impact of wastes and residues on the environment, making it an indispensable tool in recycling globally.

### **2. Cleaning and treatment of the environment**

It helps in the disposal of magnetic pollutants in the water and soil, and contributes to the restoration of environmental balance.

### **3. Food and drug processing**

It is used to support the standards of purity and safety in food and drug materials, and ensures the accurate separation of materials to achieve the standards of quality and safety.

### **4. Mining and mineral processing industry**

It plays an important role in the extraction of valuable minerals from deposits (rocks and sediments), simplifying the extraction process and increasing yield.

### **5. Chemical and petrochemical industry**

It contributes to the production process, purification of materials and removal of impurities, to achieve the standards of quality in the industry.

### **6. Electronic industries**

It plays a crucial role in the recovery of precious metals such as copper and gold from electronic remains. This contributes to reducing pollution resulting from the unsafe disposal of old electronic devices, and reduces the need to extract more of these minerals from nature.

### **7. Automotive (Cars) industry**

It is used to separate iron parts and steels from other components of old cars, making it easier to recycle them into new raw materials for new automotive industry.



## B) Electrostatic separation

**Static electricity:** a physical phenomenon that occurs as a result of an imbalance of electrical charges within or on the surface of a material.



When a substance loses some electrons (negatively charged particles) it becomes positively charged, and vice versa. This charge remains static and only moves when an electrical discharge occurs. This charge remains static and only moves when an electrical discharge occurs.

### How is static electricity generated?

Static electricity is generated by several factors, including:

1. Friction	2. Contact	3. Induction
<p>When rubbing their bodies against each other, electrons move from one object to another, causing them to charge oppositely.</p> <p><b>Example:</b> When you rub a balloon with your hair, electrons transfer from your hair to the balloon. The hair becomes positively charged and the balloon becomes negatively charged</p>	<p>When a charged body touches a neutral body is, some electrons transfer from the charged body to the neutral body, charging the neutral body.</p>	<p>When a charged body approaches a conductor body, the charges are distributed in the conductor body so that the opposite charges accumulate on the nearest surface to the charged body.</p>

### Examples of static electricity in our daily life:

#### 1. A small electric shock when touching the metal door handle in winter

This occurs due to the accumulation of electrical charges in the body as a result of friction with woolen clothes

#### 2. Hair attracting into the plastic comb after combing

This occurs due to the transfer of electrons from the hair to the comb, which leads to charging them with opposite charges

#### 3. Sticking the balloon on the walls after rubbing the hair

This happens because of the electrostatic force that attracts the negatively charged balloon to the wall that has a positive charge



### ☞ Electrostatic separation process

1. The idea is based on the exposure of a mixture of particles such as plastic to an electric field, which leads to these particles to gain positive and negative charges based on the properties of each material
  2. Then a positive charged rod and another negatively charged rod are dipped inside the charged particles mixture
  3. The positive rod will attract the particles having the negative charge and vice versa
- The electrostatic separation method** is characterized by a high ability to separate a large mixture of materials that are similar in shape, size and color, but different in electrical properties so that they can acquire charges opposite to each other.

### ☞ Disadvantages of this process

1. It needs a high degree of control of the electric current on the mixture
2. It needs to control the surrounding conditions, as any change in humidity, degree of heat or in the electric voltage will affect the separation process.

### ☞ Examples of electrostatic separating of some materials:

1. **Plastic and minerals:** Plastic (such as polyethylene or polypropylene) can be separated from metals (such as aluminum or copper) based on the different charges that each type of material acquires in the electric field.
2. **Plastic and glass:** Plastic (such as PVC) can be separated from glass as they have opposite charges when exposed to an electric field.
3. **Wheat and mineral impurities:** In agriculture, electrostatic separation can be used to separate seeds such as wheat from mineral impurities or other pollutants.

## C) Thermocycling

The process of reusing a material by utilizing its energy after its initial use. This is done by heating solid or liquid wastes to high temperatures to extract energy or converting it into new usable materials.

### ☞ Examples of thermocycling:

#### 1. Thermal plastic recycling:

Some types of plastics, such as polyethylene terephthalate (PET) and low density polyethylene (LDPE).

The process involves heating the plastic to a suitable temperature to melt, and then turning it into another form, such as new bottles or bottles.





## 2. Thermal Rubber Recycling:

Old rubber tires can be cut and heated for reuse in asphalt making, or recycled into other rubber products. Heat helps break up the chemical bonds of rubber to facilitate its reshaping.

## 3. Wastes pyrolysis:

In this process, the organic or plastic wastes waste is heated in the absence of oxygen, resulting in its decomposition into combustible gases, liquids, and solid coal that can be used as an energy source or as raw materials in other industries.

## 4. Burning of wastes to produce energy (Waste – to – Energy):

In some cases, solid waste is used to generate electricity or waste.

This method is considered a type of recycling (**G. R**) where the energy stored in the waste is converted into electrical or thermal energy that can be used to heat buildings or operate power stations.

Thermal recycling plays an important role in reducing the volume of wastes and restoring energy, but it needs strict measures to reduce harmful emissions from burning or heating processes.

## Retreatment:

The process in which, the materials are broken down into their basic components using chemical reactions.

**Example**, in glass recycling, bottles are crushed and melted in special furnaces to turn them into reconfigurable glass.

## Example:

Reaction of silica with hydrochloric acid for the analysis of glass materials



Where:

- $\text{SiO}_2$  Silicon dioxide (sand): the main component of glass
- $\text{HCl}$  Hydrochloric acid
- $\text{SiCl}_4$  Silicon tetrachloride which is a volatile liquid
- $\text{H}_2\text{O}$  Water

## Ecosystem Health Assessment:

Resource recycling techniques

- Reduce the need to extract new resources, reducing the environmental impact of mining and material extraction.
- Contribute to reducing waste dumped in landfills, preserving the health of ecosystems and biodiversity.





## Exercise lesson two

1. What principle is magnetic separation based on?
  - a) The density of materials
  - b) The electrical conductivity of materials
  - c) The magnetic properties of materials
  - d) The size of the materials
2. What is a solenoid coil composed of?
  - a) Plastic and glass
  - b) Copper wire wrapped around an iron rod
  - c) Rubber and carbon
  - d) Aluminum and plastic
3. Which of the following is a benefit of using magnetic separation in recycling?
  - a) Increase pollution of water
  - b) Increase use of landfills
  - c) Increase waste volume
  - d) Reduces impact of waste on the environment
4. What is the role of magnetic separation in the preparation of food and pharmaceuticals?
  - a) Separate food from other things
  - b) Support standards of purity and safety
  - c) Increase the taste of food
  - d) Support a fast manufacturing process
5. What kind of electric charge does a material acquire after losing electrons?
  - a) Negative
  - b) Positive
  - c) Neutral
  - d) No charge
6. How is static electricity produced by friction?
  - a) A chemical reaction
  - b) Movement of electrons from one object to another
  - c) The contact of a charged object with a neutral object
  - d) The presence of magnetic field
7. What happens when a charged object touches a neutral object?
  - a) The neutral object becomes more charged.
  - b) The neutral object becomes charged by contact.
  - c) The charged object becomes neutral.
  - d) No change occurs
8. What is pyrolysis?
  - a) The process of using chemicals to recycle waste
  - b) The process of heating waste in the absence of oxygen
  - c) The process of separating metal using magnets
  - d) The process of separating plastic using electric fields
9. Which of the following is an example of the use of thermal recycling of plastics?
  - a) Converting plastic to fuel
  - b) Recycling plastic to new products



- c) Using plastic to make glass
- d) Separating plastic and metals

**10. What is the main purpose of reprocessing?**

- a) Cleaning the used materials
- b) Crushing materials
- c) To break down the materials into basic components for reuse
- d) Disposing of the materials

**11. What is a major drawback of the electrostatic separation method?**

- a) It is an expensive process.
- b) It is a slow process
- c) It requires tight control of conditions
- d) It is not as effective as other methods

**12. What materials can be separated using electrostatic separation?**

- a) Only metals
- b) Only plastic
- c) Metals and plastic
- d) Organic materials

**13. Which of the following is an example of electrostatic separation in agriculture?**

- a) Separating iron from steel
- b) Separating glass from plastic
- c) Separating wheat from impurities
- d) Separating rubber from metal

**14. How does thermal recycling differ from chemical recycling?**

- a) Thermal recycling uses heat, chemical recycling uses chemical reactions.
- b) Thermal recycling uses chemicals, chemical recycling uses heat
- c) Thermal recycling is a physical process, chemical recycling is a biological process.
- d) Thermal recycling is a biological process, chemical recycling is a physical process.

**15. What is the primary purpose of using pyrolysis in thermal recycling?**

- a) To convert waste into energy
- b) To convert waste into reusable materials
- c) To reduce the volume of waste
- d) To reduce air pollution

**16. How do thermal and chemical recycling contribute to sustainability?**

- a) Increase waste
- b) Reduce waste volume and save energy
- c) Increase reliance on fossil fuels
- d) Promote deforestation

**17. What is the role of microorganisms in the biological decomposition process?**

- a) They create pollution
- b) They accelerate the breakdown of organic materials
- c) They neutralize acids and bases
- d) They separate metals and plastics

**18. Which of the following is not a benefit of static electricity?**

- a) A balloon sticking to a wall
- b) Hair being attracted to a comb
- c) Recycling materials by using electrostatic separation
- d) A thunderstorm

**19. Which of the following is a chemical used for sterilizing waste?**

- a) Hydrochloric acid
- b) Sodium carbonate
- c) Chlorine
- d) Biogas

**20. Which step is essential in the glass recycling process after crushing the used glass?**

- a) Heating the glass to a high temperature
- b) Chemical analysis of the glass



c) Cleaning the crushed glass

d) Disposing of the crushed

**21. What is the main principle of "conserved energy" in the context of recycling?**

- a) Energy can be created by recycling.
- b) Energy used in recycling is always less than the energy required for original production.
- c) Energy in recycling is destroyed to produce other forms of energy
- d) Total energy in a closed system always decreases with time

**22. Why is it important to consider both the benefits and drawbacks of thermal recycling?**

- a) To ignore air pollution
- b) To minimize reliance on renewable resources
- c) To develop more sustainable ways of thermal recycling
- d) To reduce the efficiency of the recycling process

**23. What are the challenges in separating different types of plastics using electrostatic separation?**

- a) Difficulty in controlling the environmental factors
- b) Difficulty in charging the plastics
- c) Difficulty in separating the metals from plastics
- d) Difficulty in creating the electric field

**24. How does the concept of "imbalance of electrical charges" help us understand static electricity?**

- a) The imbalance creates the electric current needed
- b) The imbalance creates an accumulation of charges in the material
- c) The imbalance allows electrons to move freely
- d) The imbalance creates magnetic fields that push charges away

**25. How do chemical reactions facilitate the recycling of materials like glass?**

- a) By destroying the glass
- b) By melting the glass in special furnaces
- c) By transforming the glass into its basic components
- d) By removing impurities in the glass

**Essay Questions)**

1. Compare the process of using magnetic separation and electrostatic separation in the recycling of resources. Describe the differences in the properties of the materials that enable the separation, and their applications.
2. Explain how the chemical processes of pyrolysis and chemical decomposition contribute to the recycling of waste. Describe the products from each process, and their importance in resource recovery.
3. Discuss the role of static electricity in various applications and explain the benefits and drawbacks of these processes
4. Evaluate the benefits of reusing materials through thermal recycling, and discuss its challenges, considering the negative impacts of the heat or smoke caused by this process.
5. Explain how a chemical reaction could be used to break down glass into its basic components for recycling purposes.



## Answer Key

### Multiple Choice Answers:

1. C 2.b 3.d 4.b 5. B 6. B 7. B 8.b 9.b 10-c 11.c 12. C 13.c 14. A 15. B 16. B 17. b  
18. d 19. C 20. A 21. B 22. C 23. A 24. B 25. c

### Essay Question Answers:

#### 1. **Magnetic vs. Electrostatic Separation:**

**Magnetic Separation:** Uses magnets to separate magnetic materials, such as iron and steel, from non-magnetic materials. This relies on the magnetic properties of the materials. It is commonly used for separating metals from other types of waste.

**Electrostatic Separation:** Uses an electrical field to separate materials based on their ability to hold an electric charge. This depends on the electrical properties of the materials. This is commonly used to separate plastics and glass.

#### 2. **Pyrolysis and Chemical Decomposition in Recycling:**

**Pyrolysis:** A thermal process that heats materials in the absence of oxygen, breaking them down into gases, liquids, and solid residues. The resulting gases can be used as fuels, and the liquid fractions can be further refined. Pyrolysis recovers valuable fuel and chemicals from complex waste streams.

**Chemical decomposition:** Employs chemical reactions with different chemical substances, to convert waste into basic raw materials for reuse or to be converted into fertilizer. This process uses chemical compounds to break down waste materials.

#### 3. **Role of Static Electricity:**

**Benefits:** Separation of materials in recycling, the charging of devices, and certain industrial processes.

**Drawbacks:** Can cause shocks, may damage sensitive equipment, and requires controlled conditions

#### 4. **Benefits and Challenges of Thermal Recycling:**

**Benefits:** Can reduce landfill volumes, recover energy, and process different types of materials.

**Challenges:** Potential harmful emissions, can be costly, requires high-temperature processes. To overcome these challenges new, sustainable techniques should be developed

#### 5. **Chemical Reaction for Glass Recycling:**

The equation shown in page 12 demonstrates this reaction.  $\text{SiO}_2 + 4\text{HCl} \rightarrow \text{SiCl}_4 + 2\text{H}_2\text{O}$ , where silica reacts with hydrochloric acid to produce silicon tetrachloride and water. The silicon tetrachloride can be used to produce high-purity silica, that is used in the manufacture of electronic products or other high-end materials. This process is useful in separating silica from the other components of the glass



# Lesson Three Green hydrogen as a clean fuel

In light of the increasing environmental challenges, green hydrogen is emerges as a promising clean fuel, but its production in large quantities and efficiently faces major challenges.

Living organisms play a pivotal role in this field, as some types of bacteria and algae can produce hydrogen through natural biological processes. These biological methods are characterized by their high efficiency and low environmental impact compared to traditional methods.

These organisms use light or organic matter to produce hydrogen, making them a promising option for developing sustainable energy technologies.

Therefore, investing in research and development in this field will contribute to achieving sustainable development goals and reducing dependence on traditional energy sources as the main source of energy?



"Algae farming project"



"Extraction of hydrogen from algae"

## Process of green hydrogen production:

Governments' efforts to produce the green hydrogen are facing several challenges:

1. The high costs of production
2. Limited renewable energy
3. The difficulty of storage.

Through which it is possible to launch from hydrogen gray and blue to green.

مجازي

Hydrogen has colors and is a metaphorical meaning that is done according to the way in which it is generated. (Hydrogen is a colorless gas from the base)

"Green" refers to cleaner technologies as not including any emissions (zero carbon). It can also be used as a fuel for cars directly due to its quality and purity.

"Blue" on the other hand, is less pure, has 10% carbon emissions and is suitable for industrial activities.





## Challenge to green hydrogen production

**1. Green hydrogen** remains the most expensive.

Producing one ton of it **requires 61 megawatt/hr.** of renewable electricity. Thus, replacing the grey hydrogen that is currently being produced requires 36 megawatt. Equivalent to more than **60% of the total electricity** generation capacity in Egypt

**2. The storage before consumption or transportation.**

For storage of green hydrogen there are options, including storage in salt caves or gas fields

**In Egypt,** the use of exhausted gas fields to store hydrogen in the Nile Delta and Western Desert regions.

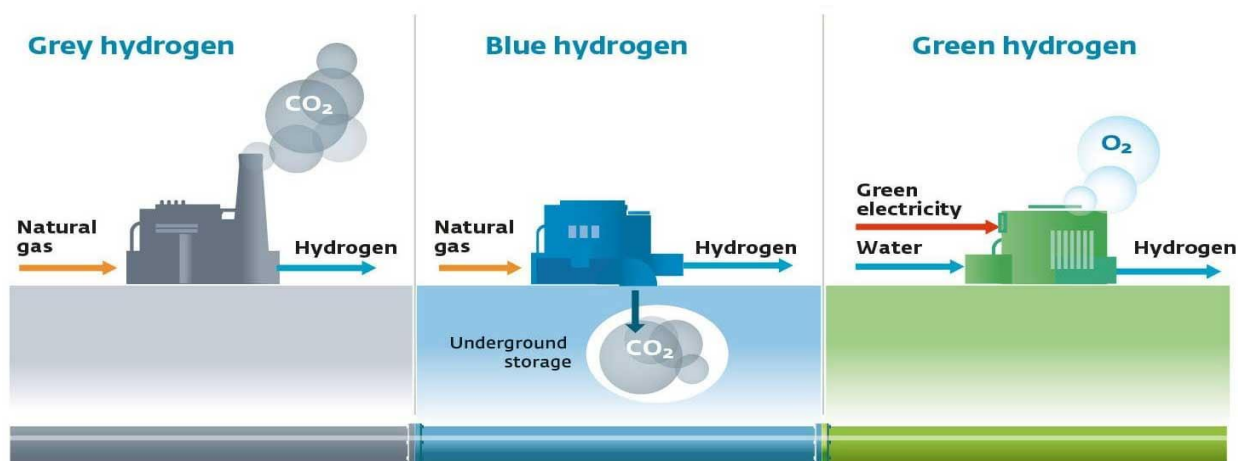
- There is no complete information about the number of salt caves, some of which are used for tourist and therapeutic purposes.

Storage in depleted wells faces a problem where hydrogen may react with the remaining material in these fields and release **hydrogen sulfide gas**

- **Hydrogen sulfide** is a **colorless, flammable gas** that smells like **mold**.

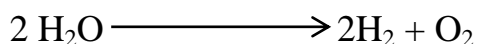
It is extracted from the gas associated with petroleum and is separated by heat and processed and condensed to facilitate its transportation.

It is widely used in chemical analysis

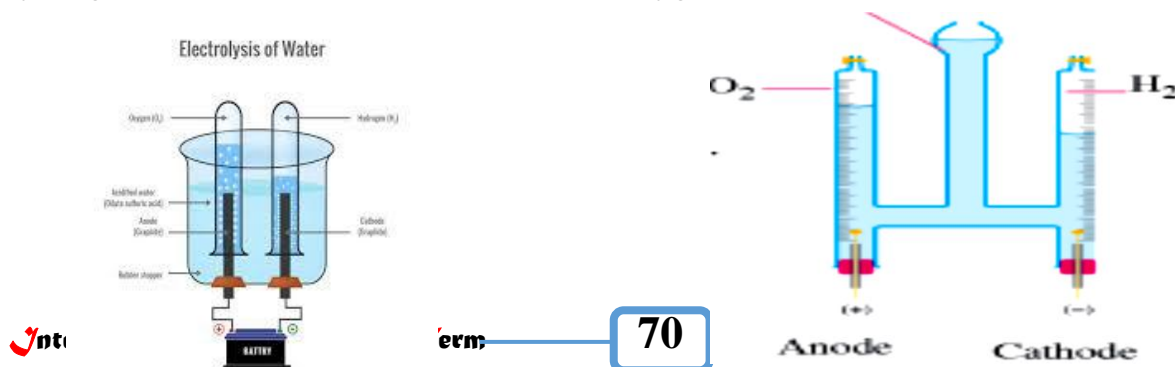


## Production of green hydrogen

Through electrolysis of water by passing an electric current through it. Thus, water separates into hydrogen and oxygen.



Hydrogen can be extracted from water as oxygen is released into the air





The basic condition in this process is for the hydrogen to be green that the electricity used in the process of electrolysis is carbon-free, i.e. the green electricity which is produced from renewable energy sources, such as water, wind and sun.

## 👉 Production of green hydrogen by biological analysis using:

### a. Bacteria

Some species such as **Clostridium** and **Enterobacter** can produce green hydrogen by decomposing organic materials in absence of air

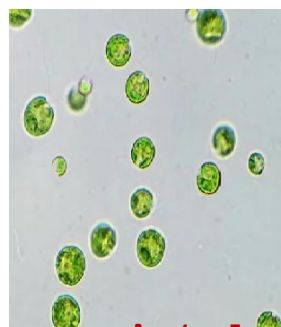


بكتيريا **Clostridium**

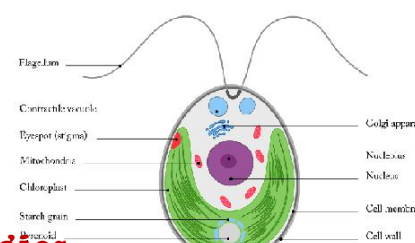
### b. Algae:

**Chlamydomonas** can produce hydrogen using solar energy during photosynthesis.

Under certain conditions (e.g. sulphur deficiency), it can convert water to hydrogen and oxygen.



**Chlamydomonas**



## 👉 Hydrogen applications in clean energy technologies:

### A. Transportation

**Hydrogen cars:** Fuel-cells convert hydrogen into electrical energy, reducing fuel use and reducing carbon emissions. Many cities have started using buses the work by hydrogen



### B. Industry

Green hydrogen can be used as an alternative to natural gas in many industrial processes.

Efficiency: Hydrogen helps reduce carbon emissions from heavy industry



### C. Improves air quality

The use of green hydrogen contributes to reducing air pollutants, which improves air quality in cities.



## **Research and investment**

### **The use of hydrogen as opposed to fossil fuels**

Imagine a world in which cars are moving, planes are flying, and factories are powered using a clean energy that does not harm the environment. This world may not be far away, thanks to renewable energy and innovative technologies such as green hydrogen.

### **Fossil fuels and environmental risks**

The world is still heavily dependent on fossil fuels such as oil, coal and natural gas. These sources come from land and require complex extraction processes, such as drilling and mining. But the big problem here is that burning fossil fuels produces CO<sub>2</sub> and other pollutants, which contribute to climate change (huge amounts of carbon dioxide) and air pollution.

### **Comparison of green hydrogen and fossil fuel**

Green hydrogen is used in many applications, such as electric vehicle power, from heavy industry, to aircraft, while Fossil fuels are used in everything from cars to electricity generation.



## EXERCISE : Lesson three

1. Green hydrogen is produced primarily through:
  - a) Burning fossil fuels
  - b) Electrolysis of water using renewable energy
  - c) Mining of rare earth elements
  - d) Chemical decomposition of methane
2. What distinguishes green hydrogen from blue hydrogen?
  - a) Green hydrogen is more expensive to produce
  - b) Green hydrogen utilizes carbon capture technologies
  - c) Green hydrogen is used only in aviation
  - d) Green hydrogen produces zero carbon emissions
3. In the absence of \_\_\_\_\_, certain bacteria can produce hydrogen.
  - a) Oxygen
  - b) Sunlight
  - c) Carbon dioxide
  - d) Water
4. Which renewable source is most commonly used in water electrolysis for hydrogen production?
  - a) Solar
  - b) Tidal
  - c) Geothermal
  - d) Hydroelectric
4. Which industry would benefit most from switching to green hydrogen?
  - a) Agriculture
  - b) Heavy Industries
  - c) Retail sector
  - d) Tourism
5. Which of the following is a disadvantage of using green hydrogen?
  - a) Water usage
  - b) Energy consumption
  - c) High Cost
  - d) Environmental impact
6. What process is used to release hydrogen and oxygen?
  - a) Electromagnets
  - b) Fuel Cell
  - c) Electrolysis
  - d) Reforming
7. What is the primary role of methanogens in the production of energy?
  - a) Convert water to methane
  - b) Converts carbon and hydrogen
  - c) Convert biomass into energy
  - d) convert hydrogen into ammonia
8. Hydrogen production requires electricity that is
  - a) Green
  - b) Red
  - c) Rainbow
  - d) Blue
9. What part of alga produces hydrogen?
  - a) Cellulose
  - b) Starch
  - c) Chlorophyll
  - d) Chloroplast
11. Which gas is released in the air with the use of electrolysis of water?
  - a) Oxygen
  - b) Carbon Dioxide
  - c) Carbon Monoxide
  - d) Ammonia
12. What is the primary disadvantage of producing green hydrogen on a large scale?
  - a) Abundance of resource
  - b) High efficiency of current methods
  - c) Cost and energy demands for sustainable source of electricity
  - d) High rate of pollution



**13. Which is an important method of producing green hydrogen?**

- a) Extraction from natural gas
- b) Through chemical process
- c) By using fuel cell
- d) Through water electrolysis

**14. What does the use of green hydrogen aim to solve about the fossil fuels?**

- a) Reduce air pollution
- b) Reduce cost of transport
- c) Reduce energy consumption
- d) Reduce the water usage

**15. What is a potential environmental concern associated with storing hydrogen in underground locations?**

- a) Increased soil fertility
- b) Release of hydrogen sulfide gas
- c) Reduced carbon dioxide levels
- d) Stabilization of soil structure

**16. Which type of bacteria are used to produce hydrogen in the absence of oxygen?**

- a) Mycoplasmas
- b) Enterobacter
- c) Rhizobia
- d) Methanogens

**17. How can electrical power from algae be obtained?**

- a) By using photosynthesis
- b) By electrolysis with high voltage
- c) By electrical storm
- d) By using fuel cell

**18. Which natural product is needed to run the process to produce green hydrogen using biological sources?**

- a) Methane
- b) Cellulose
- c) Hydrocarbons
- d) Ethanol

**19. How can using Hydrogen help the industries?**

- a) Increase carbon emission
- b) Decrease water levels
- c) Improve efficiency
- d) Decrease fossil fuel production

**20. What is "zero carbon" to Green Hydrogen production?**

- a) All the process is made without fuel burn
- b) All waste is turned to CO<sub>2</sub>
- c) No pollutant is released
- d) No gases are used.

**21. Why is it essential for the electricity used in water electrolysis for green hydrogen production to be carbon-free?**

- a) To reduce water pollution
- b) To produce pure hydrogen
- c) To ensure the process is environmentally sustainable
- d) To increase the yield of hydrogen production

**22. How can bioengineered microorganisms potentially contribute to increasing the efficiency of green hydrogen production?**

- a) By increasing the speed of electrolysis
- b) By reducing the carbon content of the water
- c) By increasing the stability of the algae
- d) By generating hydrogen with less external energy input

**23. What are the primary hurdles to be overcome in order for green hydrogen to become a widely adopted transportation fuel?**

- a) Lack of government subsidies
- b) Inadequate transportation infrastructure and economic challenges
- c) Insufficient market
- d) Lack of research





**24. How does research into new storage methods for green hydrogen help to solve any problems?**

- a) By increasing the density of Hydrogen
- b) By making hydrogen more expensive
- c) By improving the reaction processes
- d) By lowering the electricity used

**25. Which of the following best describes the role of the Hydrogen Fuel Cell?**

- a) Create new hydrogen
- b) Store hydrogen
- c) Convert hydrogen into electricity
- d) Produce carbon dioxide

**Essay Questions**

1. Compare and contrast the environmental impacts of green hydrogen production via electrolysis versus the use of bacteria. Discuss the pros and cons of each approach.
2. Evaluate the economic viability of green hydrogen production. What factors currently limit its widespread adoption, and what technological advancements could improve its economic competitiveness?
3. Discuss the challenges in transportation and storage of green hydrogen
4. Analyze the role of governmental incentives and regulations in accelerating the transition to green hydrogen-based economies.
5. Explain the chemical reactions behind utilizing algae for the extraction of green hydrogen and the uses for such hydrogen

**Answer Keys**

**Multiple Choice Answers:**

1.b 2.d 3.a 4.a 5.b 6.c 7.c 8.b 9.a 10.d 11.a 12. c 13. d 14. a 15. b 16. b  
17.d 18. b 19. c 20. c 21. C 22. d 23. b 24. a 25. C

**Essay Question Answers:**

**1. Comparison of Electrolysis vs. Bacteria for Green Hydrogen Production:**

- **Electrolysis:** Pros: Relatively clean if renewable energy sources are used. Cons: High energy consumption, potential for some greenhouse gas emissions if the electricity grid is not fully clean.
- **Bacteria:** Pros: Potential for even lower carbon footprint and lower energy consumption. Cons: Lower efficiency, challenging to scale up, reliance on specific organic materials.

**2. Economic Viability of Green Hydrogen:**

Green hydrogen is more expensive compared to the fossil fuel. Technological advancements such as high effective electrolysis and more efficient storage can be



introduced to cut the costs. Also, government grants and incentives would help accelerate the use of the technology

### 3. Challenges in Transportation and Storage:

- Transportation It is difficult to contain high volume of hydrogen gas in safe, energy-efficient ways
- Storage: Hydrogen can be stored in liquid form or compressed however these methods have their own disadvantages. Hydrogen reacts with the container as well as the material is highly flammable

### 4. Role of Governmental Incentives and Regulations:

- Incentives Can provide direct investments or help small businesses
- Regulations: Can give more stability to the market and accelerate the production of the product

### 5. Extraction of Hydrogen from Algae:

Algae performs photosynthesis which uses sunlight to perform electrolysis, and extract hydrogen and oxygen from  $H_2O$ . The Hydrogen can be collected, and converted to renewable energy source

## CHAPTER 3 : Exam 1

### FIRST : CHOOSE :

1. What is the primary goal of resource recycling?
  - (a) To deplete natural resources faster
  - (b) To reduce environmental pollution
  - (c) To increase the volume of landfills
  - (d) To make a profit for recycling companies
2. Which of the following is an example of mechanical recycling?
  - (a) Burning waste to generate electricity
  - (b) Reprocessing plastic into new products
  - (c) Using chemicals to break down waste
  - (d) Releasing biogas from organic wastes
3. In electrostatic separation, what property is exploited to separate materials?
  - (a) Density
  - (b) Magnetic susceptibility



- (c) Electrical charge
- (d) Size
- 4. Which of the following gases is both a greenhouse gas and released during decomposition in landfills?
  - a) Oxygen
  - b) Nitrogen
  - c) Methan
  - d) Carbon dioxide
- 5. What is a key advantage of chemical recycling over mechanical recycling?
  - (a) Lower cost
  - (b) Simpler process
  - (c) Ability to handle mixed waste streams
  - (d) Reduced energy consumption
- 6. Which of the following is a common use of magnetic separation?
  - a) Analyzing organic material
  - b) Separating metallic materials
  - c) Separating plastics from polymers
  - d) Producing ammonia
- 7. Which of the following statements accurately describes electrolysis?
  - a) Electrolysis occurs spontaneously and without external energy.
  - b) Electrolysis uses electricity to break down chemical bonds.
  - c) Electrolysis consumes very little energy.
  - d) Electrolysis only happens with carbon
- 8. Which type of renewable resources can be used for the electrolysis?
  - a) Metal catalysts
  - b) Chemical substances
  - c) Biogas
  - d) Solar energy
- 9. In a sustainable city of the future, which energy source are more likely to use?
  - a) Natural gas
  - b) Wood
  - c) Green hydrogen
  - d) Coal
- 10. How do you calculate the efficiency of a solar panel?
  - a) Watts given off
  - b) By watts produced for each unit of light



- c) The color of light being used
- d) Angle of solar radiation

**11. How can pyrolysis contribute to the production of clean energy?**

- a) It generates water
- b) It produces bio-oils
- c) It generates salt to help the soil
- d) It causes explosions

**12. What is a bio refinery, and why are they so important for sustainability?**

- a) Refineries made by algae
- b) Refining plants the transform waste into biofuel and electricity
- c) Transform waste into compost
- d) Transport renewable energy sources

**13. How do you ensure the quality and purity of foods during magnetic separation?**

- a) Electric field control
- b) Pressure control
- c) Precise separation for meeting the standards
- d) Temperature control

**14. What factors determine how strong the magnetic field can be?**

- a) Length of solenoid coil
- b) Strength of electric current
- c) Number of solenoid coil turns
- d) all the above

**15. If a material is being separated using electrostatic separation and is determined to be a positive charge, which electrode will it be attracted to?**

- a) No Electrode
- b) The electrode will be damaged
- c) Negative Electrode
- d) Positive Electrode

**16. Why should humidity be controlled in the electrostatic separation chamber?**

- a) It reduces the charge in the sample
- b) It helps reduce the voltage
- c) It protects the apparatus
- d) It reduces the temperature

**17. What does high power translate to for magnets used in mining?**

- a) A magnet is better for removing pollution
- b) A magnet is better at removing carbon dioxide
- c) A magnet is better at detecting
- d) A magnet is better at simplifying extraction

**18. How can humans influence the balance of the carbon cycles?**

- a) By reducing mining activities
- b) By balancing the amount of CO<sub>2</sub> in the atmosphere.
- c) By balancing the amount of H<sub>2</sub> O in the atmosphere.
- d) By stabilizing temperatures in the biosphere

**19. How is plastic broken down for thermal energy conversion?**

- a) Turned into fuel
- b) It runs a cycle to be reused.
- c) It's heated without air.
- d) Its put into a landfill.



**20. Which statement is true about the first law of thermodynamics?**

- a) Energy is created
- b) Energy is destroyed
- c) Total energy remains constant
- d) Total energy increases with use

**21. What is the role of decomposers in an ecosystem, and how does this affect energy flow?**

- a) To increase the amount of carbon in the atmosphere
- b) To prevent the transfer of energy
- c) Returns the energy from dead organisms to the atmosphere
- d) To recycle and return the energy in dead organisms back to the atmosphere.

**22. What could be wrong with trying to apply pyrolysis to materials such as uranium?**

- a) Pyrolysis does not work for toxic material.
- b) No reactions will happen
- c) Temperature required
- d) Waste is released to the atmosphere

**23. How does green chemistry help with the recycling process?**

- a) Reduces hazardous substances in the recycling processes
- b) increases hazardous substances
- c) It creates a way for the product to never decompose
- d) Increases water

**24. What is the relationship between the source and storage of materials?**

- a) storage is always underground
- b) storage is always made close to the extraction
- c) both are very important to keep energy levels sustained
- d) both cause pollution

**Essay Questions (2 Questions):**

1. Compare and contrast chemical recycling and thermal recycling, highlighting their pros and cons in terms of environmental impact and economic feasibility.
2. Explain the importance of minimizing the environmental impact of the production of green hydrogen even when electrolysis is powered by renewable sources. What are the potential environmental concerns and what measures can be taken to address them? Answer Key (Exam 1) answer

**Multiple Choice:**

1B 2b 3c 4c 5c 6b 7b 8d 9c 10b 11b 12b 13c 14d 15c 16a 17d 18b 19c 20c 21d 22c 23a 24c

**Essay Questions:**

1. Chemical Recycling vs. Thermal Recycling:

**Chemical Recycling:** This involves using chemical processes to break down waste into its constituent components. It offers the potential for high-quality recycled materials and processing of mixed waste streams. However, it may involve the use of hazardous chemicals and can be energy-intensive.)

**Thermal Recycling:** This uses high heat to convert waste into energy or other usable materials. It can handle a wider range of waste materials compared to chemical recycling, but it can result in air pollution and greenhouse gas emissions if not carefully managed







**10. What is a Bio-Oil?**

- a) A new oil substitute      b) A liquid with low density
- c) Water substitute      d) Air substitute

**11. What is the process of using organisms to recycle organic matter?**

- (a) Electrical Charge    (b) Electrostatic field
- (c) A mechanical field    (d) biochemical reactions

**12. In the "City of Tomorrow," what problem was addressed?**

- a) A lack of space      b) A lack of water
- c) Difficultly disposing of waste.      d) There was too much CO<sub>2</sub>.

**13. Which of the following techniques will prevent the formation of hazardous substances?**

- a) Recycling with chemicals      b) Electrolysis
- c) Chemical sterilization      d) Waste disposal

**14. What natural compound helps in getting rid of chemical waste?**

- a) Hydroxides      b) Water
- c) Oxygen      d) Salt

**15. What does the symbol Biogas stand for?**

- a) The recycling process      b) The process for obtaining fuel from biological substances
- c) Sterilizing bacteria      d) Creating a new chemical

**16. What must humans be concerned with when performing thermal recycling?**

- a) The size of container      b) The temperature range
- c) The waste from burning off all the pollution      d) The pollution caused by the material.

**17. What happens to the energy that is lost?**

- a) Creates friction      b) Stored in new bond
- c) Gets stored in the oceans.      d) Transforms into other forms

**18. What material helps in extraction processes?**

- a) Gold catalyst      b) Cyanide
- c) Copper      d) Silver

**19. What causes electrolysis to be efficient?**

- a) High heat      b) Renewable source of electricity
- c) Electrolyte      d) Clean water

**20. What industry uses Aluminum?**

- a) Automotive      b) Transport
- c) Aerospace      d) all the above

**21. Why is it important to consider the life cycle of a product when discussing recycling and sustainability?**

- a) So that there is waste
- b) So that we ensure it can continue to produce products
- c) So that we reduce the waste and ensure reuse at each step
- d) So that we can destroy everything

**22. Which of the following is a key consideration when evaluating the environmental impact of chemical recycling processes?**

- a) The cost of the initial chemical investment.



- b) The potential for pollution from the process.
- c) The availability of skilled labor.
- d) The potential for increased carbon emissions.

**23. What is the role of government and businesses in promotion of renewable sources of energy?**

- a) Help with logistics
- b) Financial incentives
- c) Educate the people
- d) all the above

**24. If the amount of CO<sub>2</sub> in the atmosphere is stable, how would the green house gasses increase?**

- a) Humans can stop releasing greenhouse gasses
- b) The Sun would begin releasing higher amounts of radiation
- c) The Sun would absorb more radiation
- d) The Sun would have to grow weaker

**25. Which is something that requires to have control?**

- a) Electric circuit
- b) Biological materials
- c) Chemical reaction
- d) Natural resources

**Essay Questions (5) Questions):**

1. Discuss the challenges associated with balancing the benefits of recycling with the potential negative impacts, such as pollution from recycling processes .
2. Describe the potential of chemical sterilization techniques to improve the health of a city
3. What are the environmental concerns about the use of chemicals that occur during the mining process
4. How is reusing certain materials cheaper
5. Evaluate the role of public awareness and education in promoting successful resource management and sustainable recycling p

**Answer Key (Exam 2)**

**Multiple Choice:**

1. A 2. c 3. B 4. A 5. d 6.c 7. C 8.d 9. A 10. b 11. b 12. d 13. a 14. c 15. b 16. d 17. d  
18. b 19. a 20. a 21. b 22. a 23. d 24. c 25. d

**Essay Questions**

1. Balancing Recycling Benefits and Negative Impacts: Careful selection of recycling methods, investment and public involvement.
2. Chemical Sterilization to Improve the Health of a City: Benefits of chemical sterilization can control and eliminate certain health factors and problems.)
3. Environmental Concerns about the chemicals during Mining: Damage and contamination of land, harm to people and animals.
4. Explanation for Reusing certain materials in cheaper process: The savings involved, lower costs.

The Role of Awareness: Education is k

# Chapter Four The Future of Energy

## Lesson One Biotechnology in energy development

Biotechnology is a scientific field that deals with the use of organisms or their components to achieve specific goals. This includes applications in medicine, agriculture, and industry. One of the innovative applications is the use of biotechnology to convert living organisms into energy sources.

**Bioenergy:** the energy derived from living organisms such as plants and animals. They are characterized by being renewable and environmentally friendly.

### How organisms are used in energy production?

#### A. Biodegradation

**Biodegradation:** the process of converting organic materials (such as waste) into energy using living organisms such as bacteria.

This process occurs naturally or is artificially controlled in waste storage areas that produce methane gas that can be used as an energy source.

- The following is an explanation of the main steps for biodegradation with equations:

#### Step 1: Hydrolysis

In this first phase, bacteria break down complex organic substances (such as carbohydrates, proteins, and fats) into simpler units such as sugars, amino acids, and fatty acids.

For example, starch (carbohydrates) is broken down into glucose:



#### Step 2: Fermentation Sorrel (Acidogenesis)

In this mixture, acidic bacteria convert sugars and amino acids produced by primary hydrolysis into short-chain fatty acids or alcohols, with producing gases such as carbon dioxide and hydrogen.

#### Step 3: Acetic acid production

Bacteria carry out an additional process to convert fatty acids, alcohols or gases produced in the previous step into acetic acid, hydrogen, and carbon dioxide.

#### Step 4: Methane Production (Methanogenesis)

In this final step, melthanogene bacteria convert acetic acid or carbon dioxide and hydrogen into methane (CH<sub>4</sub>) and water.



This is the most important step in the production of biogas energy.



## B. Biofuels

Biofuels are a type of energy sources produced from living organisms such as plants or algae. This includes ethanol and biodiesel

### Chemical processes of biofuel composition:

#### A. Production of bioethanol

##### Fermentation:

- The production of bioethanol begins with the conversion of starchy or sugary substances into simple sugars (such as glucose) through hydrolysis.
- Then fermentation of these sugars using yeast to produce ethanol  $\text{C}_2\text{H}_5\text{OH}$  and  $\text{CO}_2$



#### B. Biodiesel production:

In this process, vegetable oils or animal fats (containing tertiary glycerides) are reacted with alcohol (usually methanol or ethanol) in the presence of a catalyst, such as sodium hydroxide (NaOH).



## Questions





## Multiple Choice Questions on Biotechnology in Energy Development

### 1-What is bioenergy?

- a) Energy derived from fossil fuels
- b) Energy derived from living organisms
- c) Energy generated from nuclear reactions
- d) Energy from geothermal sources

### 2-Which process converts organic matter into energy using microorganisms?

- a) Photosynthesis
- b) Biodegradation
- c) Fermentation
- d) Combustion

### 3-What is the primary product of methanogenesis?

- a) Ethanol
- b) Methane
- c) Glycerin
- d) Hydrogen

### 4-What is the first step in the biodegradation process?

- a) Acidogenesis
- b) Hydrolysis
- c) Acetic acid production
- d) Methanogenesis

### 4-Which type of bacteria is involved in the production of methane?

- a) Acidophilic bacteria
- b) Methanogenic bacteria
- c) Lactic acid bacteria
- d) Fermentative bacteria

### 5-What is a major byproduct of bioethanol production?

- a) Methane
- b) Glycerin
- c) Carbon dioxide
- d) Oxygen

### 6-Which of the following is NOT a biofuel?

- a) Ethanol
- b) Biodiesel
- c) Natural gas
- d) Methanol

### 7-What is the main raw material used for bioethanol production?

- a) Animal fats
- b) Sugar or starch
- c) Coal
- d) Natural gas



**8-What chemical process is primarily used in biodiesel production?**

- a) Hydrolysis
- b) Combustion
- c) Transesterification
- d) Fermentation

**9-What is the role of yeast in bioethanol production?**

- a) To produce methane
- b) To ferment sugars into ethanol
- c) To convert fatty acids into glycerol
- d) To break down cellulose

**10-Which of the following is a benefit of using biofuels?**

- a) They are always cheaper than fossil fuels
- b) They can reduce greenhouse gas emissions
- c) They do not require any land to grow crops
- d) They are non-renewable resources

**11-What is a challenge associated with large-scale biofuel production?**

- a) Abundance of raw materials
- b) High costs and competition for land
- c) Low demand for biofuels
- d) Lack of technology

**12-Which of the following is a product of the fermentation process?**

- a) Methane
- b) Ethanol
- c) Glycerin
- d) Acetic acid

**13-What is the primary advantage of biofuels over fossil fuels?**

- a) Higher energy density
- b) Renewable and less polluting
- c) Lower production costs
- d) Longer shelf life

**14-What is produced as a by-product during biodiesel production?**

- a) Methane      b) Glycerin      c) Ethanol      d) Carbon dioxide

**15-Which of the following materials can be converted into biodiesel?**

- a) Coal      b) Vegetable oils      c) Natural gas      d) Wood

**16-What is the main chemical reaction involved in biodiesel production?**

- a) Combustion
- b) Transesterification
- c) Fermentation
- d) Hydrolysis

**17-What type of energy does biomass represent?**

- a) Non-renewable



- b) Renewable
- c) Nuclear
- d) Geothermal

**18-Which of the following is a major source of bioethanol?**

- a) Algae
- b) Corn and sugarcane
- c) Coal
- d) Natural gas

**19-What is the result of hydrolysis in biofuel production?**

- a) Production of alcohol
- b) Conversion of complex materials to simple sugars
- c) Generation of methane
- d) Creation of carbon dioxide

**20-What is a common catalyst used in biodiesel production?**

- a) Sulfuric acid
- b) Sodium hydroxide
- c) Ammonia
- d) Ethanol

**21-Which process involves the breakdown of organic matter by microorganisms?**

- a) Hydrolysis
- b) Biodegradation
- c) Distillation
- d) Fermentation

**22-What is the primary method for producing bioethanol from biomass?**

- a) Fermentation
- b) Transesterification
- c) Combustion
- d) Distillation

**24-What is the main environmental benefit of using biofuels?**

- a) They are always cheaper
- b) They do not require land
- c) They help reduce carbon emissions
- d) They increase energy consumption

**25-What type of biomass can be converted into biofuels?**

- a) Only wood
- b) Algae, crops, and waste
- c) Only animal waste
- d) Only agricultural residue

## Lesson Two Nanotechnology applications in energy



**Nanotechnology**: a science concerned with the study and processing of materials at the Nano scale (the size of 1 to 100 nanometers).

**Nano meter** =  $1 \times 10^{-9}$  meter

**This small size** allows materials to have **unique properties** that are completely different from their properties at their normal size, such as electrical conductivity, strength, chemical reaction, and optical properties.

**Nanotechnology In chemistry**, is used to improve the performance of materials in many fields such as medicine, energy, environment, and advanced industries.

You hear a lot lately about nanotechnology and that the future of humanity will change because of nanotechnology, but do you know what nanotechnology is?

What are the advantages of nanotechnology?

What are the nanotechnology applications that will change the future of humanity and energy production? We will answer these questions in this lesson

### **The importance of nanotechnology in energy and the environment:**

**1) Promoting technologies** for generating energy from non-conventional and renewable sources such as solar and wind energy

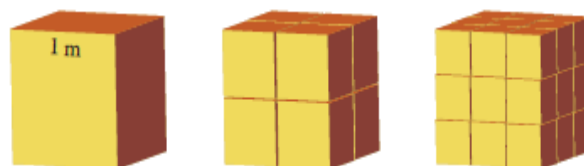
**2) Reducing energy** consumption and increasing the efficiency of its production and being environmentally friendly

**3) Increasing the effectiveness** of lighting and heating.

**4) Increasing electrical** storage capacity

**5) Reducing pollution** from energy use

➤ **The super properties of the Nano substances** are due to the relationship between the surface area and the volume



- **In the Nano volume** of the substance, the ratio between the surface area to the volume increases and the numbers of atoms exposed to reactions increase

- **This ratio between** the surface area to the volume, acquires the Nano particles new and unique physical and chemical properties

**Example**: The solubility of crushed salt and salt cubes in water

When breaking increases the number of grains increases. The volume does not change, but the surface area increases and therefore the ratio of surface area to volume increases and the solubility increases

So when the nano size is reached, the solubility property (physical property) will change than in the large salt.

### **Making of Nano material is done through two main ways:**

**1. Carving from top-down (Top to down)**


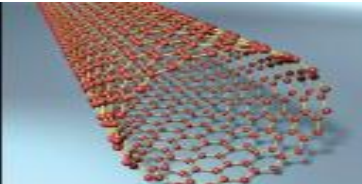
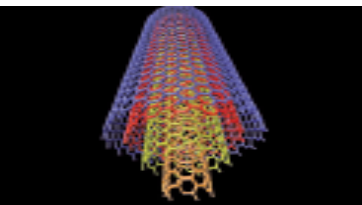



Where the material is carved from its main body to obtain very small sizes such as the method of carving statues or grinding spices

## 2. Formation from the bottom to up (Bottom to up)

Where the construction is carried out from small parts and stacked after another until we reach the required size.

### Examples of nanotechnology materials:

 <p><b>Nano fibers</b> used in production of water filters</p>	<p><b>Carbon Nanotubes</b></p>  <p>Uni</p>  <p>Multi</p>	 <p><b>Nano wires</b> used in electrical circuits</p>
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### Examples of nanotechnology applications:

1. Metallic Nano particles	2. Carbon nanotubes	3. Silver nano particles
<p>Used to catalyze chemical reactions more effectively due to their large surface area.</p> <p><b>Examples:</b></p> <p><b>a. Nanoparticles Gold:</b></p> <p>- Used in catalysing chemical reactions such as oxidation of carbon or hydrogen reactions, - They play a major role in solar and fuel catalysts.</p> <p><b>b. Nanoparticles Platinum:</b></p> <p>Used in Cell Fuel to catalyze electrochemical reactions in the electrolysis of water to reduce harmful emissions.</p>	<p>- Provide high conductivity of electricity and are used to optimize the performance of electronics and batteries.</p> <p>- Used in energy storage and compound materials to improve electrical conductivity and heat in electronics,</p> <p>- In environmental applications to purify water from pollutants</p>	<p>- They are used in medical bandages and disinfectant products because of its superior ability to kill bacteria.</p> <p>- These particles are found in anti-odor implants, dental pastes, and medical devices such as catheterization and surgery tools.</p>

### The role of nanotechnology in improving batteries





Nanotechnology plays a crucial role in improving the performance of batteries by controlling chemical reactions at the Nano scale level.

By modifying the anode (+ve electrode) and cathode (-ve electrode) using nanomaterials, it is possible to increase the energy storage capacity and reduce electrical losses.

### **a. Lithium-ion (Li-ion batteries):**

Lithium-ion batteries are a common type of rechargeable battery, used in many electronic devices such as smartphones and portable computers.

These batteries are characterized by their high capacity and efficiency, which can be improved using nanotechnologies.

### **Role of nano substances:**

#### **1. Increase surface area:**

Nano substances increase the surface area of storage and discharge interactions, which enhances battery efficiency.

#### **2. Electrical conductivity:**

The use of nano substances in anodes and cathodes can improve electrical conductivity and reduce internal resistance, resulting in total battery performance.

#### **3. Reduction of waste:**

Electrical loss can be reduced by improving the nanostructure of materials, that decreases battery degradation and increasing lifespan.

### **Purification of water and air using Nano filter:**

Water Nano filters use advanced techniques to purify water by removing pollutants that conventional filters may not remove. This filter contains micro-sized nanoparticles that allow it to eliminate small pollutants such as microbes, bacteria, heavy metals, and chemical pollutants.

## Questions



## Multiple Choice Questions on Applications of Nanotechnology in Energy

### 1-What is the primary size range for materials studied in nanotechnology?

- a) 1 to 10 micrometers
- b) 1 to 100 nanometers
- c) 1 to 10 millimeters
- d) 1 to 100 micrometers

### 2-How does nanotechnology improve the efficiency of solar cells?

- a) By increasing the size of solar cells
- b) By using nanomaterials to enhance light absorption
- c) By reducing the thickness of solar cells
- d) By using traditional materials only

### 3-What is a key benefit of using carbon nanotubes in batteries?

- a) Increased weight
- b) Decreased conductivity
- c) Improved electrical conductivity
- d) Reduced capacity

### 4-Which material is commonly used for catalyzing reactions in fuel cells?

- a) Copper
- b) Iron
- c) Platinum nanoparticles
- d) Silver

### 5-What is a major advantage of using nanoparticles in water purification?

- a) They are larger and easier to filter
- b) They can remove contaminants at a microscopic level
- c) They are made from heavy metals
- d) They are less effective than traditional filters

### 6-What type of battery is most commonly improved by nanotechnology?

- a) Nickel-cadmium batteries
- b) Lead-acid batteries
- c) Lithium-ion batteries
- d) Alkaline batteries

### 7-How does increasing the surface area of battery electrodes benefit performance?

- a) It decreases energy storage capacity
- b) It allows for more chemical reactions
- c) It makes the battery heavier
- d) It reduces lifespan

### 8-What is one application of silver nanoparticles in energy?

- a) Enhancing battery efficiency
- b) Catalyzing chemical reactions
- c) Purifying water



d) All of the above

**9-Which of the following describes the "top-down" approach in nanotechnology?**

- a) Building materials from atomic particles
- b) Breaking down larger materials into nanoscale sizes
- c) Mixing various nanomaterials
- d) Using biological organisms to create nanomaterials

**10-What is the impact of nanotechnology on energy consumption?**

- a) It generally increases energy consumption
- b) It can reduce energy consumption by improving efficiency
- c) It has no effect on energy consumption
- d) It only affects renewable energy sources

**11-Which of the following is NOT a benefit of nanotechnology in energy?**

- a) Increased efficiency of energy storage
- b) Reduction in pollution
- c) Higher costs of energy production
- d) Enhanced performance of solar cells

**12-What property of nanomaterials enhances their effectiveness in catalysis?**

- a) Low surface area
- b) High surface area to volume ratio
- c) High density
- d) Chemical inertness

**13-How can nanotechnology contribute to environmental sustainability?**

- a) By increasing waste generation
- b) By enabling the recycling of materials
- c) By promoting fossil fuel use
- d) By reducing the efficiency of energy systems

**14-What is the role of quantum dots in energy applications?**

- a) They are used for thermal insulation
- b) They enhance light absorption in solar cells
- c) They are used to store energy in batteries
- d) They are primarily used in medical applications

**15-What is one potential environmental concern related to nanotechnology?**

- a) Increased efficiency in energy production
- b) Potential toxicity of nanoparticles
- c) Decreased use of renewable resources
- d) Improved waste management

**16-Which of the following nanomaterials is known for its electrical conductivity?**

- a) Silica nanoparticles
- b) Carbon nanotubes
- c) Gold nanoparticles
- d) Clay nanoparticles

**17-How does nanotechnology improve the performance of lithium-ion batteries?**

- a) By reducing charge cycles
- b) By increasing internal resistance
- c) By enhancing energy storage capacity



d) By decreasing surface area

**18-What is a common application of metal nanoparticles in energy production?**

- a) Fuel cell catalysts                      b) Structural components
- c) Thermal insulators                      d) Conductive coatings

**19-Which of the following best describes the "bottom-up" approach in nanotechnology?**

- a) Breaking down materials into nanoscale sizes
- b) Assembling materials from nanoscale components
- c) Using conventional manufacturing methods
- d) Discarding unwanted materials

**20-What is the significance of the surface area-to-volume ratio at the nanoscale?**

- a) It decreases as size decreases
- b) It increases, enhancing reactivity and absorption
- c) It remains constant
- d) It only matters in large-scale applications

**21-Which nanomaterial can be used to enhance the efficiency of solar panels?**

- a) Copper oxide                      b) Zinc oxide nanoparticles
- c) Aluminum oxide                      d) Lead sulfate

**22-What is the function of nanofilters in water purification?**

- a) To filter out large particles only
- b) To allow all contaminants to pass through
- c) To remove small contaminants and pathogens
- d) To increase the acidity of water

**23-How do nanoparticles improve the heating efficiency of materials?**

- a) By absorbing less heat                      b) By increasing thermal conductivity
- c) By decreasing surface area                      d) By becoming inert at higher temperatures

**24-What is a potential application of nanotechnology in energy-efficient lighting?**

- a) Use of incandescent bulbs                      b) Development of quantum dot LEDs
- c) Reduction of light output                      d) Elimination of LED technology

**25-Which of the following is an example of a renewable energy technology enhanced by nanotechnology?**

- a) Coal-fired power plants
- b) Photovoltaic solar cells
- c) Nuclear power systems
- d) Natural gas turbines

**Technological innovation**



## Lesson Three

### Modern technology applications in the production of clean energy:

#### Advanced solar energy technologies:

##### Concentrated solar power CSP:

The idea of establishing CPS has been directed through the development of thermal energy storage process to obtain electrical energy during periods of clouds or before sunrise and after sunset, which are periods in which the efficiency of solar cells is significantly reduced

This method has made the process of using solar energy as a renewable source of electricity continuously and more effective than solar cells and fuel-dependent power stations



##### Mechanism of work of the concentrated solar power station:

**Mirrors** (solar reflectors) or lenses are used to focus sunlight onto receivers that direct it to a network of connected pipes adjacent to the solar reflectors and containing water.

**As the heat continues**, the temperature of the water rises and it turns into steam, which in turn passes through turbines connected to electric generators.



**When the turbines rotate** due to the pressure of the steam passing through them, this movement is transferred to the turbines to convert the kinetic energy into electrical energy.

**The heat may be used directly** in factories that depend on thermal energy in their industry, and the thermal energy may be stored in giant insulated cylinders containing molten salt that stores thermal energy and can be reused daily for a period of time Up to thirty years.

**The use of reflective materials must continue** to be improved by using materials with high specific heat capacity that improve the efficiency of converting thermal





energy into electrical energy. **For example**, materials such as **molten salt** can be used as a heat transfer medium, increasing the efficiency of heat storage Energy.

### **Technologies to be used to address the challenges of climate change.**

**Final Project:** “Designing a Sustainable Model for Energy and Natural Resources Management in a Local Community”

**In your community**, you face many challenges related to energy and natural resource management. The area suffers from inefficient energy consumption, water shortages, and increasing indoor pollution. You need to solve these problems to achieve sustainable development and improve the quality of life for citizens.

**Imagine you live in a community with these challenges.** The conditions might be:

**1- Energy** Homes and public buildings use excessive electricity, and many are not equipped with energy efficient cooling systems. Lights stay on even when not needed, and heating systems

**Water:** Farms and communities suffer from water availability problems. Leaking water from old pipes, poor management of water resources, and contamination of water sources all contribute to reduced amounts of water available.

**Pollution:** Emissions from factories and transportation increase air pollution levels. Industrial waste is disposed of improperly, leading to soil and water pollution.

### **Final product:**

Provide a sustainable model that can improve the management of energy and natural resources in your community, promoting sustainability, reducing environmental impact, and improving the quality of life for citizens.



### **Your mission**



As a sustainable designer, your mission is to improve the management of energy and natural resources in your community. You must:

**1. Analyze the current situation:** Gather information about how energy and natural resources are used in your community. Identify the main problems and analyze their causes.

**2. Find sustainable solutions:** Look for innovative solutions and best practices that can be implemented to improve energy and natural resource management. Choose solutions that can be implemented in your community.

**3. Design the model:** Create a model that integrates these sustainable solutions. Make the model applicable and address Specific problems.

**4. Present and evaluate the model:** Test the effectiveness of the model in solving problems and present it to community members Or an evaluation committee. Gather feedback and improve the model based on the results.

**5. Report Submission:** Prepare a detailed report explaining how the model was designed and implemented and the results you obtained. Submit the report to the teacher or local community.

### **Discussion Questions:**

1-How have you been able to integrate green hydrogen, nanotechnology, and biofuel technologies into your sustainable model of energy and natural resource management?

2-What are possible strategies to balance these different technologies to meet the energy and resource needs of the local community?

3-How can you evaluate the impact of these combined technologies on improving sustainability and reducing environmental impact in your project?

## Questions



## Multiple Choice Questions on Technological Innovation in Clean Energy Production

### 1-What is the primary goal of clean energy production?

- a) To increase fossil fuel consumption
- b) To reduce pollution and environmental impact
- c) To promote nuclear energy
- d) To rely on traditional energy sources

### 2-What technology is used in concentrated solar power (CSP) systems?

- a) Wind turbines
- b) Photovoltaic cells
- c) Mirrors and lenses to focus sunlight
- d) Geothermal heat pumps

### 3-How does a CSP plant generate electricity?

- a) By using solar panels to convert sunlight directly into electricity
- b) By focusing sunlight to heat water and produce steam
- c) By burning fossil fuels
- d) By harnessing wind energy

### 4-What material is commonly used for thermal energy storage in CSP systems?

- a) Water
- b) Molten salt
- c) Concrete
- d) Coal

### 5-What is a significant advantage of using molten salt in CSP?

- a) It has a low specific heat capacity
- b) It can store thermal energy for long periods
- c) It is inexpensive
- d) It is readily available in the environment

### 6-Which of the following is a benefit of advanced solar energy technologies?

- a) Increased reliance on fossil fuels
- b) Continuous energy production regardless of sunlight hours
- c) Higher installation costs
- d) Decreased energy efficiency

### 7-What role does nanotechnology play in clean energy production?

- a) Decreasing energy efficiency
- b) Enhancing the performance of solar cells and batteries
- c) Increasing reliance on coal
- d) Reducing the effectiveness of renewable technologies

### 8-Which of the following is a potential application of biofuels in clean energy?

- a) Reducing water pollution
- b) Generating energy from organic materials
- c) Promoting fossil fuel use
- d) Increasing air pollution

### 9-What is a primary challenge associated with traditional energy resources?

- a) They are renewable
- b) They contribute to climate change and pollution
- c) They are always available
- d) They are cost-effective

### 10-How can hydrogen be considered a clean energy source?

- a) It produces carbon emissions when burned



- b) It can be generated from renewable sources without polluting
- c) It is derived from fossil fuels
- d) It is difficult to store and transport

**11-What is the main purpose of energy efficiency programs in communities?**

- a) To increase energy consumption
- b) To reduce energy waste and costs
- c) To promote fossil fuel usage
- d) To decrease renewable energy adoption

**12-Which of the following technologies is often integrated with CSP to enhance efficiency?**

- a) Geothermal energy
- b) Wind turbines
- c) Thermal energy storage systems
- d) Traditional coal plants

**13-What is one benefit of using green hydrogen in energy systems?**

- a) It increases greenhouse gas emissions
- b) It can be produced using renewable energy sources
- c) It is derived from fossil fuels
- d) It requires high energy input for production

**14-What characterizes advanced solar energy technologies?**

- a) They only generate power during the day
- b) They have low efficiency and high costs
- c) They utilize innovative methods to harness solar energy
- d) They do not require any maintenance

**15-How can biofuels contribute to sustainable energy production?**

- a) By reducing reliance on renewable resources
- b) By providing an alternative to fossil fuels
- c) By increasing air pollution
- d) By promoting deforestation

**16-Which renewable energy source is often combined with nanotechnology for improved efficiency?**

- a) Coal
- b) Natural gas
- c) Solar energy
- d) Nuclear energy

**17-What is the purpose of using reflective materials in CSP systems?**

- a) To absorb sunlight
- b) To focus sunlight onto receivers
- c) To store thermal energy
- d) To convert electricity into heat

**18-Which of the following is a challenge faced by communities in managing energy and natural resources?**

- a) Excessive energy efficiency



- b) Water shortages and contamination
- c) Overabundance of clean energy
- d) Increased air quality

**19-What is one way to evaluate the effectiveness of renewable energy technologies?**

- a) Analyzing cost-effectiveness and environmental impact
- b) Measuring increased fossil fuel usage
- c) Ignoring maintenance requirements
- d) Evaluating traditional energy sources

**20-What technology can be used to manage indoor air pollution in homes?**

- a) Traditional HVAC systems
- b) Nanotechnology-based air purifiers
- c) Increased use of fossil fuels
- d) Wood-burning stoves

**21-Which of the following is an innovative solution to improve energy efficiency in buildings?**

- a) Using single-pane windows
- b) Installing energy-efficient lighting and insulation
- c) Keeping lights on all day
- d) Using outdated heating systems

**22-What is a primary benefit of integrating sustainable practices in community energy management?**

- a) Increased pollution levels
- b) Improved quality of life for residents
- c) Decreased resource availability
- d) Higher energy costs

**23-Which of the following technologies can help reduce water waste in agriculture?**

- a) Traditional irrigation methods
- b) Smart irrigation systems
- c) Flood irrigation
- d) Overhead sprinklers

**24-How does energy efficiency contribute to economic sustainability?**

- a) By increasing energy costs
- b) By reducing operational expenses for households and businesses
- c) By promoting energy wastage
- d) By relying solely on fossil fuels

**25-What is a significant environmental benefit of using advanced solar energy technologies?**

- a) Increased carbon emissions
- b) Reduction in greenhouse gas emissions
- c) Higher dependency on fossil fuels
- d) Greater air pollution

**With my best wishes**  
**Mrs. Dalia Fawzy**